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JAPANESE COASTGUARD SHIPS.

IN 1887 the Japanese government confided to the Forges et Chantiers de la Mediterranée the order for two armored coastguard boats each of 4,200 tons. This order included the armament complete, which amounted to a total weight of about 460 tons of ordnance, carriages, torpedoes, ammunition, etc. The armament consists for each boat of one 32 centimeter (12·60 in.) Canet gun of 40 calibers in length, mounted in a barbette battery, and furnished with 60 rounds of ammunition; of twelve 12 centimeter guns, with 100 rounds; five rapid-firing Hotchkiss guns with 400 rounds for each; eleven Hotchkiss revolver cannons of 37 millimeters with 1,500 rounds; two torpedo tubes, both of them fixed, one forward and the other aft, and two movable tubes for transverse fire; with these were furnished twenty torpedoes 15 ft. long. It may be mentioned that the order for this armament made the subject of competition between Armstrong, Krupp and the Forges et Chantiers, and that when it was given to the last named firm, there was also added a supplementary one for three guns of 32 centimeters and 40 calibers, to form part of the armament of a third coast guard ship, the Hashidate, that was being built in Japan in the government arsenal of Osaka. In one of the two vessels built by the Forges et Chantiers, the Matsushima and the Itsukushima, the barbette battery for the 32 centimeter gun is placed in the forward part of the first named vessel; it is protected with steel plates 300 millimeters (11·81 in.) in thickness; the tube through which the ammunition is passed up from below to the battery is protected between the armored and the upper decks by steel plates 250 millimeters (9·84 in.) thick. The 32 centimeter gun, of 40 calibers, which is mounted within the turret, weighs 66 tons; it is of course entirely of steel and is built on the general principles that characterize the Canet system; the inner tube, extending the whole length of this gun, is about 41 ft. length. No trunnion ring is shrunk on this cannon, but it is mounted within the cradle of the carriage by means of a toothed ring. The weight of projectile is 992 lb., and that of the powder charge 617 lb.; the initial velocity is 2,300 ft., and the total striking energy is 11,200 tons. From this it follows that at close range this gun is capable of penetrating wrought iron plate about 60 in. thick or a steel plate 27·50 in. The maximum range is 12·5 miles and the highest angle of fire 30 deg. The gun is mounted on a carriage so designed that it has been possible to reduce the internal diameter of the turret to something less than 34 ft. The gun is placed within a cradle sliding on an underframe that turns around an axis supported, as well as the presses which serve to raise the frame for the vertical training, by a platform; a central tube that moves with this platform is employed to pass up the ammunition from below to the turret. This tube is supported by a pivot on the deck of the ship; at its lower part it carries a toothed ring actuated by gear that is worked by the same hydraulic presses with which the gun is trained horizontally. The arrangement is that on the well known Canet system with which our readers are familiar. An important difference between the three ships is with regard to the position of the one heavy 32 centimeter gun carried by each. On the Itsukushima this gun is fitted in a barbette forward, in the Matsushima it is placed aft, while that of the Hashidate is situated amidships. It is difficult to account for these varied positions of the principal gun on the three sister ships.

The battery is protected by a shield, in which an opening is formed to allow the gun to pass; to the rear is placed the shelter for the man training the gun, protected by steel plates 4·32 in. thick, and in the front is a sheltered loophole. The trainer who stands on the platform in the shelter has within reach the various levers and other mechanism for handling the gun both for elevation and for direction; all these operations are performed by hydraulic machinery, the water for which is furnished by a steam pump, which in case of necessity can be replaced by a hand pump. The water is brought by a feed pipe to a central distributing apparatus placed upon the platform; from this it is delivered to the various controlling apparatus, and is finally discharged into an upper tank, whence it is brought by another pipe to a lower tank. The controlling apparatus consists of double and single acting slide valves, which insure a very uniform distribution of water.

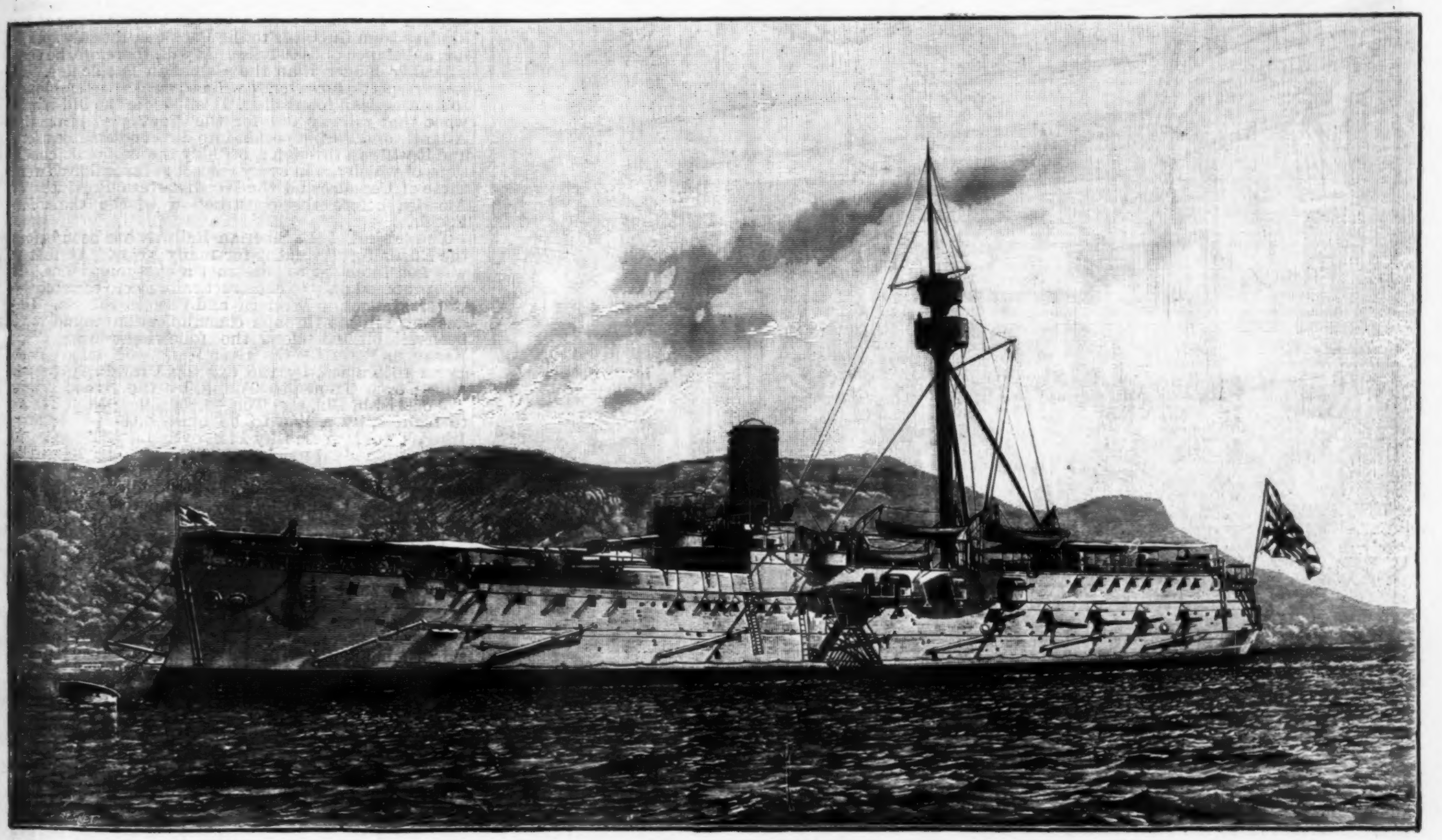
The various appliances, which are on the platform under the hand of the man controlling the gun, are: 1, a handwheel for training the gun for elevation; 2, the handwheel for training the gun in direction; 3, the lever for throwing the gun into, and out of, firing position; 4, the lever for operating the ammunition hoist; 5, the handwheel for operating the safety bolt by which the battery is locked in any given position; 6, the lever for controlling the hydraulic loading ram; 7, the valve controlling the jet for cleaning the gun. Water is delivered to the hydraulic machinery under a pressure of 80 kilogrammes per square centimeter (1,137 lb. per square inch); the hydraulic pumps furnish 300 liters per minute. The ammunition in the stores is shifted by means of a small tramway and a differential winch by which both projectiles and cartridges can be shifted to any desired position; they are thus brought under the circular tramway placed beneath the platform that carries the presses for training the battery for direction. The cradles carrying the ammunition are lowered by means of a winch upon a cage divided into three compartments, mounted on the foot of the pivot and turning with it; from this last receptacle the ammunition is shifted into the porte-charges.

The Itsukushima and her sister vessel, the Matsushima, were built in the workshops of the company at La Seyne, from the plans and specifications of M. Bertin, a French naval architect, employed by the Japanese government. The principal dimensions are as follows:

Length between perpendiculars...	295 ft. 3 in.
Beam....................................	57 ft.
Mean draught of water...	19 ft. 8 in.
Mean displacement................	4,277 tons.
Draught of water aft.	21 ft. 1 in.

These vessels, the bows of which are armed with a spur, are protected with an armor deck of steel plates 0·79 in. thick riveted over a double plating of steel 0·39 in. thick, so that the total thickness is 1·58 in. The space between this and the upper deck is about 13 ft. 3 in high, and is subdivided into a large number of compartments formed by water tight longitudinal and transverse bulkheads; access to these compartments is obtained by hatches formed in the upper deck. Each vessel is protected from end to end by a longitudinal caisson divided into a number of compartments and filled with cellulose; the various openings made in the armor deck are protected by inclined glacis 1·97 in. thick and protective framing filled also with cellulose.

The ships are fitted with a single mast made of steel plate, which is utilized for the ventilation of the lower part of the ship; two tops are attached to the mast, the lower one for Hotchkiss revolving guns and the upper one for riflemen. Four electric search light projectors are fitted, one at each end of the bridge, one forward and one aft on the deck, while the interior of the ship is lit entirely by the electric light. The machinery fitted to this vessel includes two main independent engines, each driving a separate screw shaft; these engines, which are direct acting, and slightly inclined, can be worked either with double or triple expansion; the latter is employed for the higher speeds, which range from 10 to 15 knots. There are two auxiliary engines for working the circulating, feed, and air pumps; there are four ventilating engines, a pumping machine capable of discharging more than 1,100 cubic meters of water per hour, besides a number of smaller auxiliary engines. Steam is provided by six boilers each with three furnaces, the working pressure being 170 lb. per square inch. When the engines are being worked with triple expansion, the indicated horse power is somewhat less than 2,000; with double



THE JAPANESE WAR SHIP ITSUKUSHIMA.

expansion this is increased to 3,410 horse power, and with forced draught this can be raised to 5,400 horse power. Some of the dimensions of the engines are as follows:

Diameter of small cylinder	15·35 in.
" intermediate cylinder	24·41 "
" low pressure "	56·70 "
Length of stroke	39·37 "
Total heating surface	15,243 sq. ft.
Working steam pressure	170 lb. per sq. in.

In August last the Itsukushima was put in commission at Toulon, her crew having arrived from Japan. The principal particulars of the ship are as below:

Length	324 ft. 10 in.
Beam	50 ft. 10 in.
Depth	35 ft. 0 in.
Draught (mean)	21 ft. 2 in.
Displacement	4277 tons.

Launched in the summer of 1889, the Itsukushima was ready for her steam trials in September, 1890, when a maximum speed of 16·54 knots per hour was obtained at sea, being an excess of 0·54 knot on the speed specified.—*Engineering.*

THE SCREW FERRY BOAT CINCINNATI.

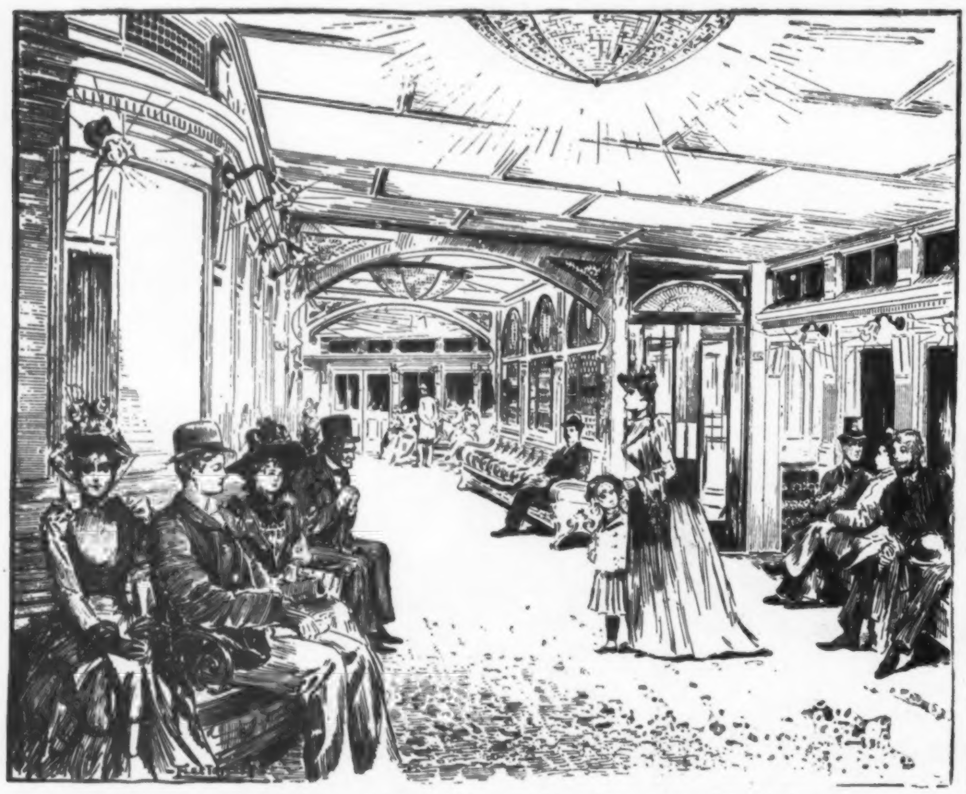
THE latest improvements in the construction of ferry boats have been utilized in the new ferry boat of the Pennsylvania Railroad Co., the Cincinnati. This boat was designed for service between New York City and the Jersey City station of the Pennsylvania Railroad. An important modification in this typical modern ferry boat is the use of screws instead of paddle wheels for propulsion, and the many advantages thus rendered possible are clearly apparent in the new boat. About two years ago the feasibility of adopting screws for ferry boats was first established, and since then the building and placing in service of the Bergen has dispelled all doubts as to the practicability of applying screw propulsion to this class of river craft. The further success of the John G. McCullough, built for service on the New York, Lake Erie & Western R.R. ferries, in the matter of ease of handling, surplus of power and high speed, influenced the decision of the Pennsylvania Railroad Co. to construct two boats of the same type.

The first of these, the Cincinnati, has been plying with most satisfactory results for the past two months. The design of the earlier boats has in some measure been departed from, especially in the case of the engines, which, instead of being triple expansion, as those of the Bergen are, are of the steeple compound type, the low pressure cylinder being mounted on top of the high pressure cylinder, and having a common piston rod. The principal dimensions of the boat are: Length over all, 206 ft.; length of hull, 200 ft.; beam over guards, 65 ft.; beam of hull, 46 ft.; depth of hull, 17 ft.; draught, 10 ft. 10 in.; displacement, 800 tons.

Any one who wishes to realize the immense superiority of the new style of ferry boat cannot do so more satisfactorily than by taking a trip across the river on a rainy day by the Cincinnati and returning on one of the older boats. The latter have all the stuffy, clammy atmosphere which has come to be regarded as inseparable from the ferry boat under such conditions, while the new boat is light, roomy, and well ventilated. On a trip by night the real luxury of the screw ferry boat is even more markedly apparent. Rows of incandescent lamps on silver brackets, and with opalescent shades, run from one end to the other of the lower saloons, and of the saloon on the upper deck, and fill the boat with cheerful light. The lower saloons, which are tastefully paneled, are painted in metal gray, and the dentils and mouldings in the panels are covered with aluminum leaf. The windows are of heavy plate glass; those at either end and in the center are handsomely ornamented with designs in leaded glass.

One of the most striking features is the absence of the usual paddle wheel house. In its stead is a handsomely carved stairway of mahogany, which leads to the upper deck. At the top of this staircase is an oval shaped dome, adjacent to which is a large sunlight set in the roof of the saloon. This is thickly studded with beaded glass, through which, intensified by reflection, the light of a cluster of incandescent lamps gives a more brilliant effect. The upper saloon is painted in salmon color, and the floor is richly carpeted. To insure a soft and uniform light nothing but electric lamps are used throughout the boat.

The lighting plant consists of two dynamos, one a United States 200-light and the other an Edison 35-light machine; each machine is run by separate "Ideal" horizontal engines. Of the total number of 200 lamps with which the boat is fitted, the large dynamo feeds such as are used at night for the illumination of the saloons. The smaller dynamo supplies the signal lamps and the cabins and such lamps as are in use in the hold, engine rooms, and elsewhere during the day. An additional advantage of the smaller dynamo is that it is held in reserve for use in case the necessity arises of stopping the large machine. Every known precaution has been taken in the wiring of the boat to avoid risk of fire, and the wires may be regarded as absolutely safe. Another point of excellence is the special arrangements for heating and ventilating. The ordinary method of heating ferry boats by steam pipes placed under the seats, and ventilating by means of holes in the ceiling, answers fairly well on short trip ferries, where the frequent opening and shutting of the doors at the end of the cabins gives a certain supplementary ventilation, but there are times, as every passenger knows, when the heaviness and foulness of the air become almost insupportable. In the Cincinnati the fresh air is taken from a point above the upper deck, through a vertical pipe, and passed to a Sturtevant blower near the engine room. The air is then forced along the steam pipes. It can be brought to any required temperature, according to the speed of the blower and the pressure of the steam in the pipes. From these heating coils the air passes by pipes to the different cabins, the largest pipe supplying the men's cabin, where the air is sure to be vitiated with tobacco smoke. The women's cabin and the cabin on the upper deck are supplied by separate pipes. In order to avoid draughts, the warm, fresh air is delivered through openings in the inner walls of the cabins near the ceilings. The foul air exits are placed under the seats, and conduct the air to the vehicle gangway. The temperature of all the apartments is governed by electric thermostats which control valves for the proper regulation of the hot and cold air supply at the heater.



ELECTRIC LIGHTING ON THE FERRY BOAT CINCINNATI.

Effective signaling arrangements are established between the engine room and the pilot house, which show the engineer the direction in which the boat is going, and the pilot the speed and direction of the revolution of the shaft. An additional safeguard against fire is provided by the absence of wood in the construction of the boat below the main deck. The efficiency and appearance of the Cincinnati reflect great credit on Mr. H. S. Hayward, superintendent of the Motive Power Department of the United Railroads of the New Jersey division of the Pennsylvania Railroad, who supervised the designing and construction of the boat. The sister boat to the Cincinnati, the Washington, which is to resemble her in every detail, is to be ready for service in three or four months.—*Electricity.*

A SPECIAL train on the Pennsylvania Railroad lately ran from Jersey City to Washington in 4 hours 11 minutes—251 minutes—the distance being 227 miles. The weight of the cars was 125 tons, and of the locomotive and tender 76½ tons.

THE TRANS-SIBERIAN RAILWAY.

IT has been publicly stated that the severe reverse which has this winter befallen the Russian empire will necessitate the postponement, if not the abandonment, of the construction of the Trans-siberian Railway. The statement has not, however, been officially confirmed, nor is it likely that it will be. There can of course be no doubt that the terrible drain on Russia's resources which the famine will occasion must prejudicially affect the speedy execution of the works; but to suspend operations at the present moment would be an act of folly, as the work will provide suitable and profitable employment for many of the sufferers from the famine.

An enormous fund has been raised for the relief of the famine stricken, and Russia, if only to prevent it from demoralizing, would be well advised to employ on the railway as many as possible of those to whom relief is given. The directors of the undertaking, who at the present moment are in the Ural region, are apparently of this opinion, for, according to recent advices, they have made urgent representations to M. Hubbenet, the Minister of Ways and Communications, that during the winter season such work as can be carried out should be actively proceeded with. The Finance Minister, M. Vishnegradsky, on whose shoulders at this juncture so great a responsibility rests, is believed to question the advisability of this course, but a higher authority is declared to have overruled his objections. The Czarevitch, whose recent tour through Siberia has led to his taking the greatest interest in the proposed railway, will shortly, it is stated, be intrusted with its supreme direction.

We do not propose in the present article to do more than give a general view of the whole undertaking. Detailed estimates have been prepared by the engineers concerning the major portion of the line, but at the present stage of affairs details cannot be regarded as of much value. The undertaking will not, so far as engineering difficulties are concerned, present many features of special interest; but it is of supreme importance to the whole world in its political and commercial aspects. It will, of course, be the biggest thing of its kind, as from the Urals to the Pacific is, roughly speaking, a distance of 5,000 miles. It will, therefore, be considerably longer than the Canadian Pacific line. In some respects, however, it will bear a close resemblance to its American forerunner. It will do for the Old World what that railway did for the New, viz., bring the Atlantic and Pacific oceans into direct communication, and it will run through a country the economic conditions of which are in every respect as favorable as were those of Canada and the Northwestern Provinces of America before the construction of the Canadian Pacific.

The subject of the Siberian Railway has been before the Russian government for many years. At first it was not intended to construct a continuous line. It was proposed only to construct railways to connect the water systems of Western and Eastern Siberia. Under this scheme through communication would have been established along the following route: From Kazan to Perm, by the river Kama—597 miles; from Perm to Tumen, by the existing Ural Railway—512 miles; from Tumen to Tomsk, by the rivers Toora, Tobol, Irtish, Obi, and Tom—1,856 miles; from Tomsk to Irkutsk, by a line to be built—1,034 miles; from Irkutsk to Mweesoffsky Pier, over Lake Baikal—100 miles; from Mweesoffsky to Srjetensk, by a line to be built—669 miles; from Srjetensk to Graffsky, by the Amoor and Ussuri Rivers—1,525 miles; and from Graffsky to Vladivostok, by a line to be built—255 miles.

This combined water and railway system had the merit of cheapness. Its cost was estimated at only £23,500,000. But the objections to the scheme were many, the chief being that by it communication between European Russia and Siberia would only be possible, as now, during about four and a half months, while the waterways are open, and that during that short period slow communication only would be possible. Under such circumstances the scheme was abandoned. It did not promise to be of much benefit to Russia, either from a political or from a commercial point of view.

When the commission of engineers came to consider the project of a continuous line of railway, they found it a difficult matter to decide on the starting point. They had three proposals before them. The first was to make use of the existing isolated Ural Railway by extending it westward and eastward. It was suggested that a line should be built to connect Perm with Nijni Novgorod, and that from Tumen the line should be extended across Siberia, by way of Nijni-Oodinsk, Irkutsk, and Srjetensk.

The second proposal was to extend the Oofa-Zalatavost line to Miass, and to build a line by way of Tukalinisk, Kainsk, Nijni-Oodinsk, Irkutsk, etc. The third was to make Orenburg—the terminus of the Samara-Orenburg Railway—the starting point and to carry the line through the Kirghiz Steppes, and the districts of of Akmonelsk, Semipalatinsk, Biesk, and Minoosensk, Nijni-Oodinsk, etc. Eastward of the last named place the route was the same in the three proposals. Westward of this town, by the first plan 2,343 miles of rail would have to be laid; by the second, 1,820 miles; by the third, 2,254 miles.

The second plan has been adopted. On reference to the accompanying map it will be seen that the route from Miass is by far the most direct. It has also other advantages. The country it passes through is less difficult, richer, and more populous than the districts through which the other routes proceed. The line, if carried along this route, would therefore be built at a less cost and bring in a larger revenue than if constructed according to either of the other plans.

The line will pass through many districts—especially in the neighborhood of Lake Baikal, and in the Trans-Baikal district—which possess a rich and varied flora and fauna, a scenery which resembles that of Switzerland, only on a larger scale, and a climate which, though severe enough in winter, is in summer mid-European in character.

The termini of this gigantic line will thus be Miass and Vladivostok. Miass, a small town in the center of one of the richest mining districts of the world, is situated on the eastern slopes of the Urals. The line—a short one of twenty miles—to connect it with Zlatavost on the western slopes of those mountains has al-

ready been constructed. Vladivostok is Russia's principal port on the Pacific, and works are in progress designed to render its harbor capable of accommodating the whole Russian Pacific fleet, and to convert the place into a second Sebastopol.

The importance of Vladivostok is already becoming realized. A telegram from Shanghai to the *Figaro*—of Dec 3, 1891.—states that the British Admiralty authorities are very much disquieted by the rapid development of the port. The Russians will, in the course of a few months, possess at this point a military position of great strength, and have at their disposal a fleet of fast cruisers which could safely assure their supremacy in the Yellow Sea. In order to remedy the great danger which such a position threatens us with, England intends to contract a defensive alliance with China.

The whole line is divided into six sections, the names of which, proceeding from west to east, are, 1, the Western line, 2, the Central line, 3, the Baikal line, 4, the Trans-Baikal line, 5, the Srjetensk-Graffsky line, 6, the Graffsky-Vladivostok line. The two last named sections are sometimes classed together as the Ussuri section. As our readers are probably aware, considerable progress has been made during the year with section 6. The section was taken in hand first, owing to its strategic importance.

The Western line will extend from Miass to the river Obi, a distance of 1,028 miles, and pass through the districts of Koorgan, Eshemsky, Tukalinsk, part of Omsk and Petropavlovsk, Kainsk and Tomsk. The population of these districts is estimated at nearly a million, being at the rate of 4·5 persons to the square mile. The principal towns *en route* are Tchelabinsk, Koorgan, Tukalinsk, Kainsk, Kolivan; the principal rivers crossed, the Tobol, Ishim, Irtish. As will be seen from the map, the line does not diverge to take in Omsk. It will be connected with that important town by a branch line about sixty miles long. Another branch line will probably be constructed to connect Tchelabinsk with a station—either Ekaterinaburg or Ostroffsky—on the isolated Ural Railway. The sub-sections of the western line are (*a*) Miass to Tchelabinsk, sixty-four miles, (*b*) Tchelabinsk to the river Obi, 964 miles. The shorter portion, on account of the mountainous character of the region which it will traverse, is estimated to cost half as much again per mile as the longer. The total cost of the whole section, including rolling stock, rails, stations, bridges, etc., is put at £6,752,000, or an average per mile of about £6,570. This estimate only allows for a pontoon bridge over the Irtish. The expense of permanent iron structure would raise the total cost by £128,000. In the construction of this section the engineers will not meet with difficulties of a serious character. Between Tchelabinsk and the Obi the country is a perfect table land. Only in bridging the rivers will much labor be required, and this can be procured without difficulty.

The central line will cover a distance of 1,114 miles. The principal towns *en route* will be Atchinsk, Krasnoyarsk, Nijni-Oodinsk, Oochtoosky, and Irkutsk, which will form the eastern termini of its five sub-sections, respectively 321, 115, 355, 158, and 165 miles long. Tomsk will be connected with this section by a short branch line. Sub-sections two and three will be the most expensive portions of this section. The line here will have to be cut through a spur of the Gremyachefsk mountains and taken across the high table land watered by the rivers Yenesei, Kam, Borusa, and Ooda. Difficulties will also be met with in constructing the last sub-section, on account of the hills and the broad rivers. Viewed as a whole, the country to be traversed by the central line is in marked contrast to that west of the Obi. Instead of being a table land, the ground gradually rises until Lake Baikal is reached, at an altitude of 1,600 ft. above the sea level. The average cost per mile of this section is not, however, anticipated to exceed much that of the Western line. On the assumption that the broad expanses of the Rivers Obi and Yenesei—here nearly three-quarters of a mile wide—are crossed by means of ferries, at £20,000 for each river, the total cost of this section will be only £7,335,000, or only £6,580 per mile. If for ferries pontoons are substituted, a further expense of £66,000 will be incurred; and if permanent structures are erected, a further sum of £641,000. Materials for the construction of this section will be obtained without difficulty. The district is thickly wooded, and iron is abundant. An enormous quantity of the latter metal is smelted every year at the Nicholaiffsky Iron Works. The labor obtainable will not, however, be of good quality, as the natives of these parts are not used to severe exertion.

The Baikal line, although the shortest section—194 miles long—will be the most expensive. Its total cost is put at £2,674,000, *i. e.*, about £13,780 per mile—nearly twice as much per mile as either of the preceding sections. This is owing to the mountainous character of the district. The Zirekeszinsky mountain range will have to be pierced by a tunnel nearly three miles long, the cost of which will be about £200,000. The section will have as its eastern terminus a steamboat station called Mweesoffsky Pier, on the southeastern shore of Lake Baikal. The chief intermediate stations will be Maifot and Kooltook.

The Trans-Baikal line, 669 miles long, also presents difficult features. Proceeding from Mweesoffsky Pier along the valley of the Seeling, the line will cross that river—here over 3,000 ft. wide—and then enter on a rocky region at an altitude of 3,700 ft. It will then descend into the valley of the Lena, and proceed thence into the basin of the Amoor. At Chita it will again meet with mountainous country, and crossing the river Nertcha will terminate at Srjetensk, the well-known Amoor steamboat station. It will have four sub-sections—(*a*) The Seelinginsk, 107 miles; (*b*) the Verchne-Oodinsk, 275 miles; (*c*) the Chitinsk, 188 miles; (*d*) the Nertchinsk, 99 miles. Its total cost, allowing only for a ferry for the Seeling, is put at £6,094,000, or £9,110 per mile. A permanent bridge over the Seeling would increase the cost by £305,000. The country traversed by this section will yield abundant supplies of material for use in the construction of the line. It contains no lack of sand, clay, stones, granite, lime, coal, and wood.

The Srjetensk-Graffsky section will cover a distance of 1,525 miles. Although this portion of the route has not been surveyed, the character of the country is fairly well known, and no difficulties worth speaking of are anticipated. The total cost of the section is put roughly at £10,222,000, or about £6,700 per mile.

The Graffsky-Vladivostok section, which is only 255 miles, is deemed of the greatest political importance. The Chinese contemplate constructing a line through Manchuria, the route of which has been surveyed by English engineers, and the Russian government has become fearful lest the Chinese cast longing eyes on the rich province of the Ussuri. In a letter to M. Vishnegradsky of the 7th May, 1890, M. De Giers, in urging the importance of constructing the Siberian Railway, said, "The Chinese may not now have any hostile intentions against Russia, but Russia can never be certain that such ideas may not hereafter enter their heads, especially if they were brought into collision with any of the European naval powers. In this event the possessions of Russia in Eastern Siberia, cut off as they now are seven months out of the twelve every year, would be in an exceedingly precarious position."

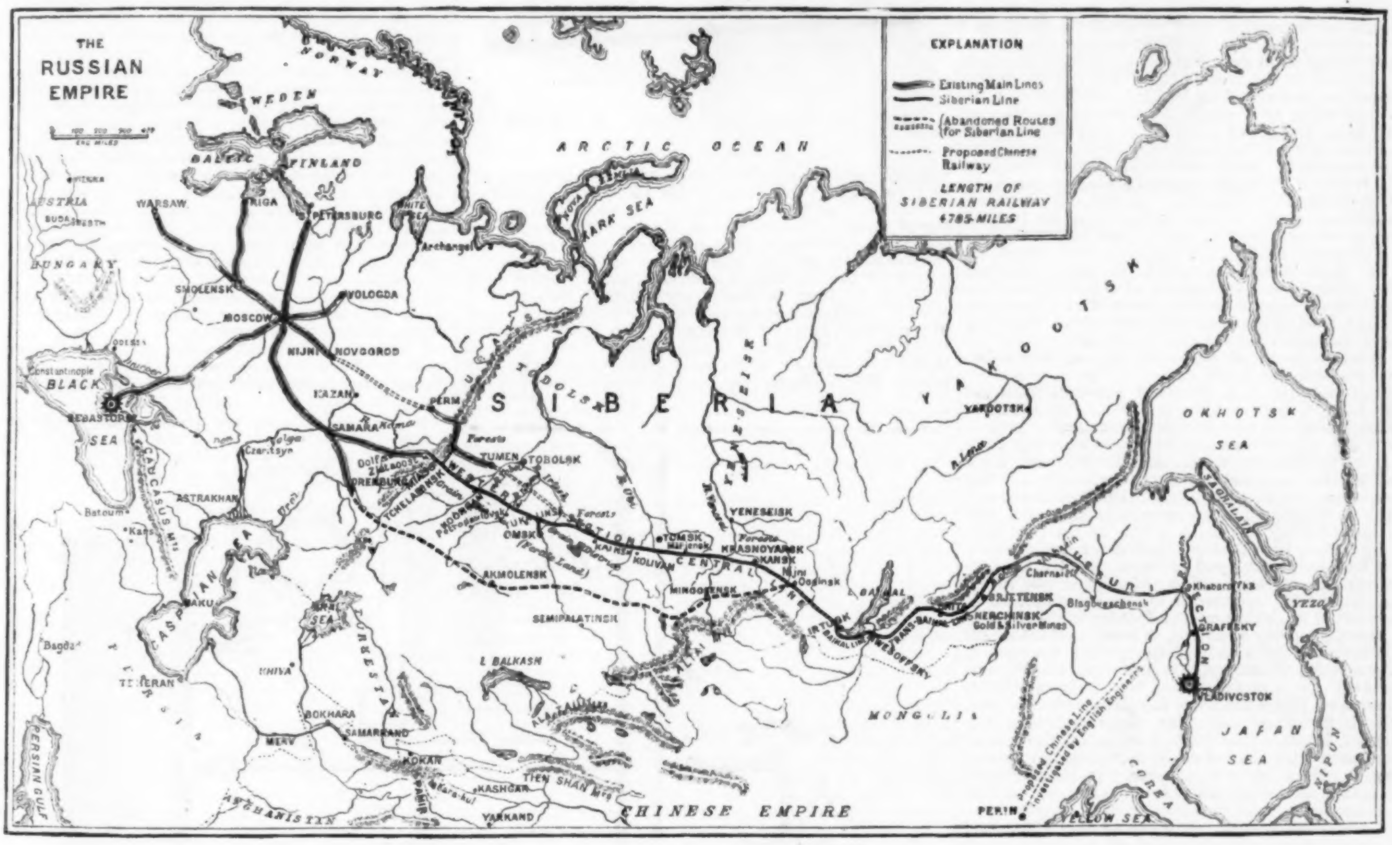
The cost of this, the final section, is put at £2,614,000, or £10,250 per mile. This high figure is occasioned, not by the nature of the country, but by the fact that the materials and labor will have to be conveyed from Russia by sea.

The following table shows the length and probable cost, with and without bridges over the broad rivers, of the several sections:

Section.	Length. Miles.	Cost with permanent bridges. £	Cost without permanent bridges. £
1. Western line	1,028	6,880,000	6,752,000
2. Central line	1,114	7,976,000	7,335,000
3. Baikal line	194	2,674,000	2,674,000
4. Trans-Baikal line	669	6,399,000	6,094,000
5. Svjetensk-Graffsky line	1,525	10,222,000	10,222,000
6. Graffsky-Vladivostok line	255	2,614,000	2,614,000
	4,785	36,765,000	35,691,000

We have not space to dwell upon the benefits which it is hoped will accrue from the railway. In deciding on its construction, the Russian government have doubtless had mainly in view the consolidation of the empire and the better defense of the remote Siberian provinces; but no doubt is entertained in official quarters that in the end the undertaking will and must be a commercial success. For the districts through which the line will pass are, contrary, to the ideas of most people in this country, full of potential wealth. In Western Siberia, and in the Amoor and Ussuri regions, there stretch vast tracts of the finest black earth, highly suitable for colonization purposes; while in Central and Eastern Siberia all kinds of minerals are already obtained, by the primitive methods in use, in the greatest abundance. Since 1834 there has been an output from these provinces of gold alone of about thirty million ounces.

Calculating on the basis of the very considerable carrying trade at present in existence in tea, manufactured goods, and grain, and taking into account the saving which will be effected in the transport of prisoners, troops, officials, and government stores the government estimate the probable revenue of the line at £3,224,000. The expenditure they put at £3,481,000—being £1,400,000 for interest at 4 per cent. on £35,000,000, and £2,081,000 for maintenance and management. The deficit, £257,000, would be met by a subsidy, but it is confidently expected that the line will not have been opened many years before it will pay its way without state assistance. —*The Engineer.*



MAP SHOWING ROUTE OF PROPOSED SIBERIAN RAILWAY.

A NEW USE FOR PORTLAND CEMENT AS A STRUCTURAL MATERIAL.

PORTLAND cement, says *The Engineer*, has been long and favorably known as a material which fulfilled the requirements of the engineer in a more perfect manner than any of its rivals or substitutes. When used in air its property of adhesion to all kinds of silicious aggregates and its capability of remaining unset after the addition of water to render it plastic and workable for a time relatively considerable have led to its employment in the place of less tractable materials, with almost uniform success; when adopted for the purposes for which it was originally designed, namely, such as involved contact with fresh or salt water, its comparative indifference to the solvent powers of either menstruum rendered possible and cheap works that would otherwise have been immensely costly, if not wholly impracticable.

Although the compressional strength of Portland cement concrete is undoubtedly high, and a high compressional strength is the one thing needed in the more obvious applications which can be made of it, yet its strength in tension is but low, and its adaptability is in consequence limited in certain respects. The high tensile strength possessed by wrought iron naturally suggests the possibility of supplementing the deficiencies of cement concrete in this particular by the incorporation with it of a skeleton or framework of this metal. As in many similar instances, the practical outcome of these theoretical considerations was due to the deliberations

of a man endeavoring to satisfy a definite need acutely and personally felt by him. A Paris gardener, named Monier, desired to obtain tubs for flowers and shrubs that should be stronger than wood and less weighty than artificial stone. He therefore bethought him of making a sort of cage resembling the modern wrought iron carboy hamper and casting round it a complete shell of concrete, or cement mortar, to speak with greater precision. This plan proved so successful that a syndicate was formed to develop it, and patents were taken out to protect it both abroad and in this country. Simple as this sounds, the attainment of complete success was only reached by laborious experiments conducted by the ablest experts procurable; the result is to be found in the establishment of what is practically a new industry, and to judge by Continental experience, one likely to achieve a considerable measure of success.

The first objection that might reasonably be urged to a method of this kind is one based on a consideration of the difference between the coefficients of expansion of iron and cement mortar. Obviously if a structure consist of iron rods embedded in a sort of artificial stone, and the expansion and contraction of the two result in a movement of their surfaces relative to each other, the destruction of their mutual adhesion is probable, and the collapse of the structure as a whole an immediate possibility.

No view, however, formed on *a priori* grounds is tenable in the face of experimental evidence to which it runs counter, and investigations conducted by Bauschinger prove that the difference in the coefficients of expansion of the two widely diverse materials used in the Monier system is not too great to overtask their elasticity or adhesion. With regard to the latter quality, he finds that it amounts to something like 40 kilos. per square centimeter, though this certainly seems a somewhat high figure; even a much smaller amount would provide a considerable margin of safety.

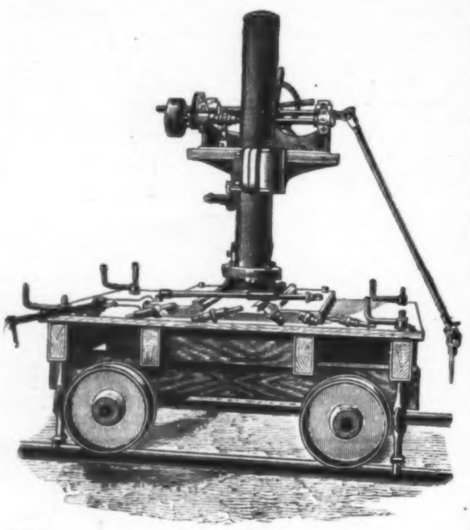
It will be easily understood that a material of this description is capable of widely different applications. The Monier system is adapted for the construction of bridges, gas holder tanks, water reservoirs, sewers, fireproof structures, furnaces—with, of course, the usual refractory lining—and even fortifications. The method usually adopted in the case of light flying bridges for foot passengers and such like traffic is the formation of an arch consisting of a single thickness of the Monier material, while bridges to carry heavier loads are made with a similar supporting span with brick abutments and superstructure. The cost of the system for most purposes is stated to be lower than that of the methods which it is designed to replace. In point of strength the capabilities of the Monier system can be judged from an experiment carried out by the Imperial Austrian Southern Railway Company, in which a bridge 30 ft. in span and 12 ft. in width, having a Monier arch with a thickness of 6 in. at the center, was tested first with rolling stock and afterward with a dead load of 196 tons, with the result that the brickwork failed, owing to the abutment not being strong enough to resist the end thrust, while the Monier arch suffered little damage. It is, however, probably in its use as a fireproof material that the product of the Monier system will find its most extensive utilization. Existing methods of fireproof construction often fail, either from lack of non-conducting powers or from mechanical weakness. Direct tests indicate that neither of these faults can be ascribed to the Monier system. It is stated that sufficient confidence is felt in the new method of construction to justify the issue of an order by the chief of the Berlin Fire Brigade to the effect that firemen may enter buildings in which it has been employed without fearing the collapse of ceilings or walls. The third large use which may be specifically spoken of is the manufacture of watercourses of all kinds on the Monier system. The cost of pipes, properly so called, of steel, cast iron, and earthenware, increases at a disproportionate rate in the larger sizes; moreover, the question of efficient joints has always to be faced, and is sometimes difficult of settlement. Pipes made on the Monier system can be built in continuous lengths, thus avoiding the necessity of joints. The cost of some of the larger sizes compared with that of other materials is given as follows: A glazed stoneware pipe, 2 ft. in diameter, may be taken as costing 16s. 9d. per yard, as against 10s. 3d. for concrete and 8s. 6d. for Monier; similarly, a 4 ft. cast iron pipe may be put down at about 70s., and a Monier pipe of the same diameter 30s.

It may be contended that the use of iron with cement mortar as a structural material is not new in this country, a contention which is literally true. A method saw the light some years ago which had for its underlying principle the same notion as that embodied in the Monier system. As to the priority of the inventions and their respective advantages, we must refrain from expressing an opinion; it is sufficient to say that the point of originality, and, indeed, the fundamental characteristic of the Monier system, lies in the use of square bar iron not woven into a network, but simply laid crosswise and held together at the points of contact by wire ties. When the whole matter was recently discussed at the meeting of the Association of German Cement Makers held in February last, it was pointed out that the method of tying the constituent rods together was not intended to impart strength to the structure, this being obtained by the adhesion of the cement mortar to the iron. Since, according to Bauschinger's experiments, this seems to be ample, no better method of attachment appears necessary.

The importance of the fact that a considerable departure in methods of building construction of all kinds is possibly imminent needs no special demonstration on our part; nor is it necessary to enlarge upon the effect of the additional output that may be expected to follow upon the cement trade of this country. One word of warning must, however, be given. Granted that the combination of two such diverse materials as cement mortar and iron be mechanically unobjectionable, there exists a chemical aspect of the question which must not be overlooked. If from any cause cracks occur in the cement which penetrate to the embedded metal, corrosion will inevitably take place should air and moisture find access thereto. Experience shows that such cracking and corrosion are by no means improbable, direct evidence being afforded in this connection by Dyckerhoff, at the meeting of German cement makers mentioned above. Cracks due to mechanical causes may be avoided by insisting upon all structures built on this system possessing a large factor of safety; by the systematic testing and analysis of the cement, and the careful selection of the sand, any fear of unsoundness in the mortar used may also be removed. The fulfillment of both conditions will go a long way toward the attainment of industrial success.

VAIL'S BOILER TUBE EXPANDING MACHINE.

AN interesting tool, designed by Mr. A. Vail, General Master Mechanic of the Western New York and Pennsylvania, is shown in the illustration. It has a



BOILER TUBE EXPANDING MACHINE

vertical column mounted on a wooden platform, carried on four truck wheels. On the column is carried a crosshead holding a mechanism which drives a universal shaft. The crosshead is raised and lowered by means of the crank shown. There is a rack on the column and a pinion with a pawl on the crosshead. Power for the machine is derived from any convenient shafting or from a stationary engine conveniently placed. Rail clamps are provided to hold the machine in position in front of the engine, and there is at the front end of the truck a center wheel arranged to be raised and lowered, to which is attached a tongue by which the machine can be pulled to any part of the shop. The wheels are loose on the axle on one side of the truck.

When it is more convenient, this machine is driven with a raw hide rope, and it is also used to tap and drill stay bolt holes, and various different tools are used in connection with the universal shaft, the action of which can be governed by the hand wheel.

As an example of the value of this machine in a locomotive shop, it is stated that 262 tubes were expanded at both ends, ready for beading, in five hours, which included the changing of the machine from one end of the boiler to the other. This is a successful adaptation of power to two of the most tedious operations in locomotive boiler building, namely, the screw staying and the tube setting, and adds another useful tool to the large number which have been recently brought out for decreasing the cost of locomotives.—*Railroad Gazette.*

COMPRESSION OF STEEL CASTINGS.

SORENE C. ROCKMAN, of Philadelphia, Pa., is the author of this process, recently patented.

Fig. 1 represents a partly side and partly sectional view in elevation of an apparatus for casting steel. Fig. 2 represents a plan view of the apparatus shown in Fig. 1, parts being in section. Fig. 3 represents a view of a mould for casting large ingots. Fig. 4 represents a section on line *xx*, Fig. 3.

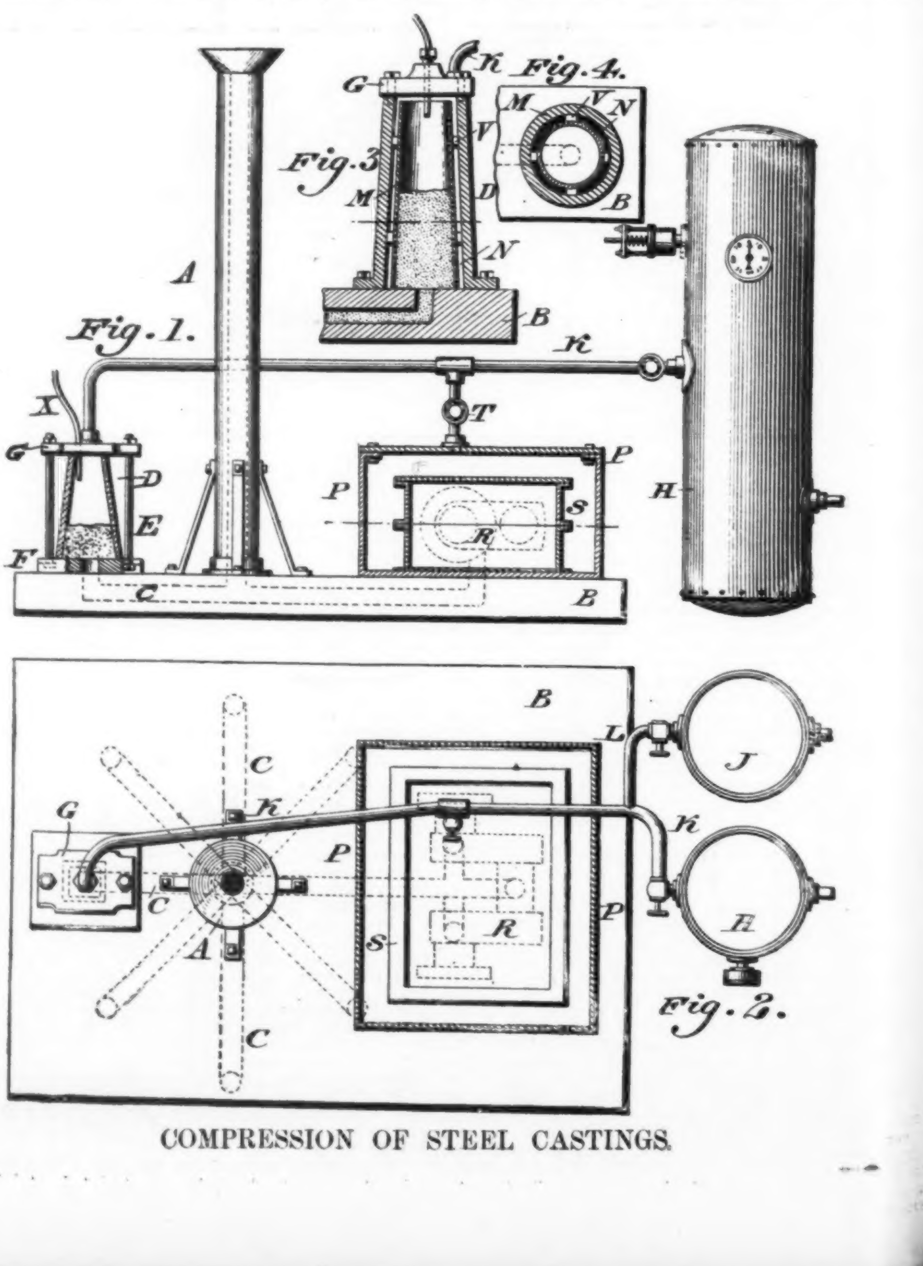
A designates a runner of any suitable height, firmly secured to a base, B, the latter having therein the ducts, C, leading from said runner into an opening in the base of the frame of the ingot mould, D. The frame, E, of the said mould is formed of a base, F, and a cover plate, G, which inclose the ends of the mould, D, and are firmly secured by bolts having their ends inserted in openings in said base and plate, having nuts thereon.

H and J represent, respectively, low and high pressure compressed air or steam receivers having the pipes, K and L, leading therefrom, the pipe, K, leading into the top of the mould, D, and the pipe, L, into the pipe, K. Each of the pipes, K and L, is provided with a stop cock, so that the air or steam supply can be shut off from either receiver, as desired.

For casting large ingots, the mould, D, is formed with an inner yielding or flexible shell, M, as shown in Fig. 3, the latter having a surrounding space, N, communicating with the air or steam supply, the said shell being kept in place by the clay plugs, V, located between the shell and outer casing of the mould.

P designates an air-tight box having an opening in its base for the entrance of a duct, C, to the interior of a sand mould, R, in the flask, S, in said box. A pipe, T, connected with the pipe, K, leads into the box, P, and the flask, S, which is of the usual construction, has an opening leading into the top of the interior of the sand mould. Any number of ducts may be made in the base leading from the runner, A, and moulds connected therewith, if desired.

To ascertain the height in the mould that is necessary to be filled with metal, a small pipe, X, is passed through the cover plate, so that its lower end is at the



COMPRESSION OF STEEL CASTINGS.

desired height in the mould. During the filling a current of air or steam will pass out through the pipe; but when the metal has reached the desired height, the opening in the lower end of the pipe will be closed, so the supply to the runner can then be stopped.

The operation is as follows: The cock of the receiver, J, being closed and that of the receiver, H opened, the melted metal is poured into the runner, A, at the top thereof, and, descending, enters a duct, C, and from thence passes into the bottom of a mould. The air or steam pressure is regulated according to the pressure of the weight of metal in the runner above that in the mould, so that the pressure on the upper and lower sides of the mass in the mould will be substantially equal, the escape of extra air or steam by the valve, V, preventing the excess of the air or steam pressure. The air or steam bears uniformly on the upper face of the metal as it enters the mould, so that the metal is under constant compression the entire time while entering and forming in the mould. When the mould is filled, the air or steam supply from the low pressure receiver, H, is shut off, and the cock of the high pressure receiver, J, opened, so that a much greater pressure is constantly exerted upon the metal while cooling and solidifying, making a sound and close-grained metal casting free from honeycomb, cavities, pipings, or blow holes.

In the mould shown in Fig. 3, the air or steam passing into the mould enters also the space, N, and presses equally upon all sides of the thin and yielding shell, M, containing the melted metal as well as upon the top of the metal, thus making a perfect compressed ingot or casting.

In the process herein described, when employing a runner of ordinary size, the pressure of air or steam from the low pressure receiver during the filling of the mould will be about thirty-six pounds to the inch, and when filled the amount of pressure from the high pressure receiver employed will be about seven hundred to one thousand pounds to the inch.

In the use of the sand mould, R, the cocks of the pipes, K and T, are opened, and that of the pipe, L, closed, so that the air or steam from the pipe, K, and the receiver, H, enters the mould through the opening in its top at the same time that the metal enters the bottom of the mould, so that the pressure is constantly exerted during the filling of the mould. When the mould is filled, the low pressure receiver is shut off and the high pressure receiver is connected with the interior of the mould. The sand mould may be employed at the same time as the ingot mould, or a number of either ingot or sand moulds be operated either separately or conjointly, as desired, however, for the sake of clearness, a single ingot mould and a single sand mould being shown in the drawings. The runner, A, is made considerably longer or higher than the mould, so that great air or steam pressure is necessary on the metal in the mould to balance the weight of the metal in the runner above the mould, thus obtaining a heavy pressure on the metal in the mould for compressing the same.

In making castings where no after pressure is required when the mould is filled, I make a cover with a conical opening and a small aperture or outlet. When the mould is now filled, the steel chills in the aperture, and thereby closes the mould, the metal in the runner above the mould serving to compress the metal in the mould.

The base, to which the runner is secured and which contains the ducts leading to the moulds, may be above the latter, if so desired, instead of under, as shown. The moulds may be cast either separately or a number combined, which latter is preferable for small ingots.

IMPROVED RAISING MACHINE.

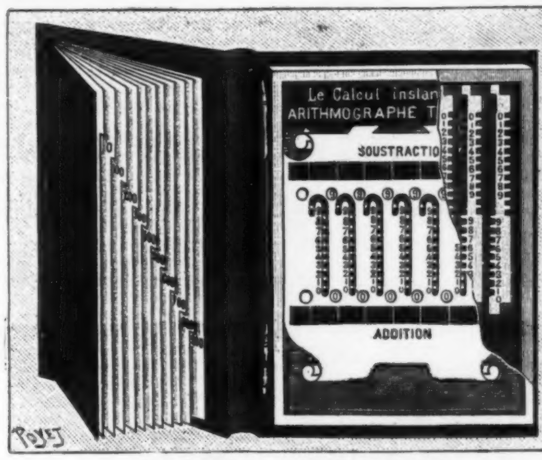
FOR flannelettes the machine of Edward Moser, of Leeds, is very generally used. This is shown in a diagrammatic form. It contains 14 small card rollers, and the cloths are run through the machine in such a way as to bring it five times into contact with the card rollers. The peculiarity of this machine is that not only do the card rollers revolve rapidly on their own axes, but the whole 14 revolve round a common axis. In doing so they come in contact with a cleansing roller which clears off any fluff accumulated on them. Besides these card rollers there are guide rollers, batching rollers, plaiting apparatus, and brushing rollers.

In all these raising machines there is a large quantity of fluff produced which accumulates to a very large extent. This is undesirable and dangerous, as such fluff is very inflammable. A spark will set it on fire, and this will spread with great rapidity. It is as well, therefore, to take steps to keep the fluff down as much as possible in order to avoid any risk or damage.—*Dyer and Calico Printer.*

INSTANTANEOUS MECHANICAL CALCULATOR.

THERE has been room for a long time for a very cheap calculating machine that will permit of performing elementary operations, addition especially, in a simple and trustworthy manner. Such a machine, devised by Mr. Troncet, is now in the market, and we have been using it long enough to be able to present it to our readers as a really practical apparatus.

It has the form of a small pocket note book, 4 in. in width by 6 in length. When it is opened we find the mechanical part upon the right side, and a black, slate-coated sheet upon the left side. The latter serves as a cover to a multiplication table from 1 to 999. A small slate pencil having a metallic point accompanies the apparatus. The instructions show that it is possible to perform the four elementary operations of addition, subtraction, multiplication, and division. This is perfectly true, but subtraction is so simple an operation that it can be quickly effected without the aid of any apparatus. As for division, which is a series of multiplications and subtractions, we do not think that we can gain any time or operate any more surely by the use of the arithmograph, the name given to the apparatus by its inventor.



TRONCET'S ARITHMOGRAPH.

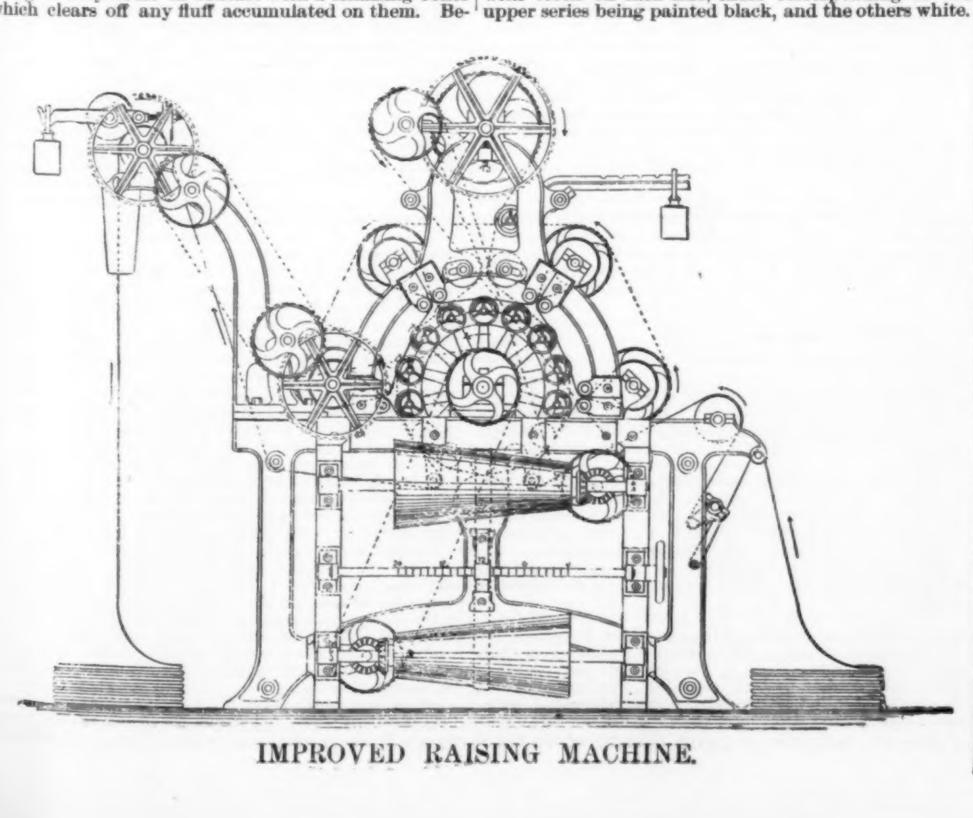
For multiplying, we have recourse to the table, in which are arranged, in a very simple order and one that facilitates researches, the products by the series of numbers 1 to 999. A multiplication by a single cipher is therefore found already made on opening the table at the desired place. When there are several ciphers in the multiplication, it suffices to seek the partial products and to add them by means of the machine. It is therefore especially a totalizer, and it is from this point of view solely that we are going to examine it.

It is formed of a fixed plate of metal provided with a series of slots, seven in number, curved at the top. At the side of each of these slots is inscribed the series of numbers from 0 to 9. Under this fixed part there is a movable one (see right of figure), which consists of strips of metal carrying two times in inverse order the series of the first ten numbers. They are provided with teeth on each side, those corresponding to the upper series being painted black, and the others white. It is these teeth that alone appear under the slots of the fixed part. As for the figures, they are not visible until they pass before a little round window over each movable strip. In the normal state, as may be seen from the engraving, it is the 9 that appears at the top window and the 0 at the bottom one. It is the latter that is designed for addition. In the state of rest, we have 0 everywhere. If we introduce the point that tips our slate pencil into the extreme right column, for example, opposite the figure 1 inscribed against the slot, and make it slide toward the bottom until it abuts against the fixed part, it will carry along the movable part so as to bring the corresponding figure 1 opposite the window, at the place where the 0 was; but the result of this operation will have been to displace, by one tooth, the entire movable part of this column, and the figures inscribed upon the fixed part not having moved, those that are opposite upon the movable part consequently become higher by one unit.

They would have been so by 2, 3, 4 ... more units if, instead of lowering the cipher 1, we had lowered ciphers 2, 3, 4, etc. It will be understood that if we operate in the same way for afterward adding another unit, for example, when we place our point opposite the 1 of the fixed part, it is really opposite 1 + the unit previously added that it will be placed. Let us continue thus up to 9, and we shall see at this moment that, if we wish to continue, the teeth between which our points fall are black, instead of being white. The instructions at the top of the apparatus tell us that in this case it is necessary to move the point upward and to proceed to the end of the slot, that is to say, through the curved portion. It will be seen, in fact, that the object of this is to act with the point upon the preceding column and to do the carrying forward, and at the same time to bring back the column of units to 0. This arrangement is most ingenious and simple. What we have just said for one column evidently applies to all the others, and the apparatus permits of adding up to ten million.

Despite the somewhat lengthy explanation into which we have thought it our duty to enter, the instrument is extremely simple, and when a person takes it in hand, he grasps the operation of it at once. For operating with certainty, there are only two things to be done, and that is to place the point exactly opposite the figure to be added, and to move it upward or downward, according to the color of the teeth between which it falls.

These two conditions being fulfilled, we may be sure of our total, however refractory be the addition. Aside from the services that Mr. Troncet's arithmograph will render to all those who are not used to adding long columns of figures, we think it will be also very useful to the business man as a verifier. He will be able, in fact, to inscribe each receipt upon the apparatus at the same time that he inscribes it in his journal. At the close of the day the total will be found ready, and all that he will have to do will be to see if the money is in the safe.—*La Nature.*



IMPROVED RAISING MACHINE.

WATERPROOFING PULP.

THE United Indurated Fiber Co., of Portland, Maine, U. S. A., give the following particulars relating to a composition of matter for waterproofing pulp articles. The pulp is saturated with an oxidizing compound and then subjected to a high degree of heat, whereby the compound is oxidized within the pores of the pulp. Linseed oil has hitherto formed the chief material used for this purpose. It is an oxidizing oil well adapted to the process and oxidizes into a hard and tough gum, giving the fiber great strength and toughness. Its high cost, however, has led to the use of resin as a means of cheapening the cost of the bath, but when resin alone or dissolved naphtha was introduced with the linseed oil it resulted in rendering the pulp brittle in proportion to the amount used. Resin may be rendered available for this use and its objectionable qualities removed by the use of cotton seed oil, which, though an oxidizing oil, is oxidized with such difficulty as to be for practical purposes a non-oxidizing oil. The cotton seed oil softens up the resin and frees it from brittleness, at the same time becoming partially oxidized, while the linseed oil is present to supply the necessary strength and toughness. The process consists of the composition of matter for waterproofing pulp, composed of resin, linseed oil, and cotton seed oil. In use sixty per cent. of resin is dissolved, for the purpose of facilitating its mixture with the other ingredients, in thirty per cent. of naphtha, and then added ten per cent. of boiled linseed oil. To this mixture is added thirty per cent. of crude cotton seed oil. The mixture is heated to 150 degrees F. and the ware soaked in it. After soaking, the ware is allowed to stand exposed to the air to remove the bulk of the naphtha, and it is then baked at a temperature of 250 degrees F. until the mixture is thoroughly oxidized within the body of the

pulp. The ware treated with this material is hard and tough, and is without brittleness incident to the presence of resin, and, it is claimed, is much cheaper than the material hitherto used for this class of work.

THE APPLICATION OF THE ALPHA-SULPHONIC ACID OF NAPHTHALENE* TO THE BATING AND PURING OF HIDES AND SKINS.

By PETER S. BURNS, S.B., and CHARLES S. HULL.

IMPROVEMENTS in the arts during the last half century, and more especially as regards the manufacture of leather, are confined almost entirely to methods for decreasing the cost through the adaptation of machinery; and little progress has been effected in the chemical methods employed, either to apply the present agents with greater economy, or new agents that may introduce economy of material or betterment in the quality of the finished product.

To briefly summarize the process of tanning, it may be said that the softened hide or skin is immersed in a solution of slaked lime, or other alkali, for a period varying from three days to a week. It is then taken out, and the hair, which is loosened by the action of the alkali, is mechanically removed. The skin would now be ready for the tanning liquors, were it not for the presence of the lime, which the fiber and gelatine of the skin absorb, and which it is necessary to remove before the tanning of the skin may be attempted. The necessity of removing the lime arises from the fact that, with it, tannic acid forms an insoluble compound, dark in color, on account of the coloring matter with which it is precipitated, and also because of the oxidation of the tannate of lime in the presence of the alkali of the hide. It is found that, besides becoming dark in color when lime is present, the hide tans very slowly, and that when the process of tanning is complete, the leather so produced is brittle and tender. It is in the removal of the lime that one of the greatest losses of material in the present methods occur, through a loss of gelatine to the hide structure itself. The processes now in use for the removal of the lime are invariably accompanied by and dependent upon the action of bacteria, which subsist upon and consume the hide while it is subjected to their action. These methods consist in immersing the hide in an animal or vegetable putrescent or fermenting solution, and the agents usually employed are hen, pigeon, or dog manure, sugar, glucose, and bran. The action of these agents by the dissolution of the gelatine results in the depletion of the hide, and allows of the removal of the lime. This is effected principally by mechanical means, such as working and washing, and is rendered possible only through the action of the bacteria on the hide structure itself, which becomes wasted and relaxed. Our experiments show that the removal of the lime is assisted by the carbonic and phosphoric acids and their ammonium salts, which were found to be present in the putrescent solution, as well as by formic, acetic, propionic, lactic, butyric, or other similar acids incident to the fermentations which are commonly resorted to. The loss of gelatine incident to these methods was found by experiment to amount to, as a minimum, from two to three per cent. of the weight of the dry hide submitted to their action. This loss is nearly doubled in the tanned leather, owing to the fact that leather may be considered to contain one-half its dry weight of tannic acid. Our experiments on this subject have been made with the object of procuring an antiseptic chemical agent that would remove the lime without the attendant action of bacteria, and consequently without loss of gelatine to the hide. It is evident that the best way of removing the alkali is by converting it into a soluble salt by the use of an acid; but the common mineral acids whose lime salts are soluble act upon the hide in a most unexpected way, causing it to swell and assume a transparent and gelatinous appearance, thus rendering the hide useless for making most kinds of leather. The acids produced by the fermentation of bran, sugar, and glucose give similarly unfavorable results; from which fact we are led to the conclusion that, when hides are submitted to *fermenting* solutions of these same agents, the depletion is due to the action of the bacteria, and not to the direct action of the acetic and other acids simultaneously generated. The organic acids were widely investigated, and from among the long list alpha-naphthalene-sulphonic acid alone was found to combine with and remove the alkali of the hide without mechanical aid, leaving the hide soft and white, and without entailing any loss of gelatine. Why the sulphonic acid of naphthalene should remove the lime without causing the swelling and gelatinous appearance produced by the other acids, of which, perhaps, citric acid produces the most marked effect, we are unable to say at present. The antiseptic properties of naphthalene-sulphonic acid, which are about the same as α-phenol-sulphonic acid, make it most desirable for the use to which it is proposed to put it, while the low cost of the materials from which it is manufactured should bring it within the tanner's reach. The application of naphthalene-sulphonic acid to the manufacture of leather on a larger scale than was possible at the laboratory was made at the works of one of the largest calfskin tanners in New York State. Two lots of calfskins were taken for the trial, alike in condition and character. Each lot numbered 150 skins, and each weighed 880 pounds in the hair. Each skin of each lot was then given a distinguishing mark, and after the treatment with lime and removal of the hair, one lot of 150 skins was subjected to the hen manure drench and the other lot to a three per cent. solution of the sulphonic acid of naphthalene. Both lots were then mixed and tanned in the same vats for the purpose of securing equal conditions. When the tanning was completed the skins were sorted into their original lots and weighed. It was found that the skins subjected to the hen manure solution made 255 pounds of dry leather, which, when stuffed, weighed 395 pounds; and that the skins treated with the naphthalene-sulphonic acid made 266½ pounds of dry leather and 413 pounds of stuffed leather; both lots having been stuffed in the same operation—a net gain in finished weight of $4\frac{35}{100}$ per cent. It was also noted that the hen manure skins were very apparently lighter in the flanks and shoulders than those bated with the sulphonic acid. The safety and certainty with which this operation may be repeated by the most ignorant of workmen, thereby insuring equality in value of the finished product, give it a great advantage over the present agents, which, aside from being very nasty and offensive, even to workmen familiar with their stench, are continually accompanied, especially in summer, by danger to the stock, even in the hands of the most experienced workmen.—*Technology Quarterly.*

* This alpha-sulphonic acid of napthalene is sold for tanners' use under the name "Acrilene Antiseptic Bating and Puring Acid."

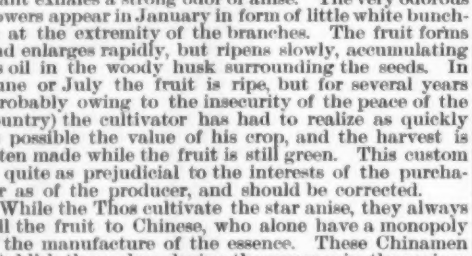
STAR ANISE AND ITS OIL.

DOCTOR P. NEIS, a French traveler and commissioner to Tonquin, writing in 1888, speaks as follows of the cultivation of star anise in that region:

The *Illicium anisatum*, or star anise, is a charming Magnoliaceæ which is said to be of spontaneous growth in some of the forests of Tonquin, but is usually seen as cultivated by the Thos upon hillsides. It is a tree of 10 to 15 m. height, with evergreen leafage, like a large myrtle, of pyramidal form, with straight branches, and with leaves at the extremities of the twigs only. The culture of this tree is the source of the prosperity of the country, owing to the value of the oil, or, more especially, of the essence extracted from its fruits. The whole plant exhales a strong odor of anise. The very odorous flowers appear in January in form of little white bunches at the extremity of the branches. The fruit forms and enlarges rapidly, but ripens slowly, accumulating its oil in the woody husk surrounding the seeds. In June or July the fruit is ripe, but for several years (probably owing to the insecurity of the peace of the country) the cultivator has had to realize as quickly as possible the value of his crop, and the harvest is often made while the fruit is still green. This custom is quite as prejudicial to the interests of the purchaser as of the producer, and should be corrected.

While the Thos cultivate the star anise, they always sell the fruit to Chinese, who alone have a monopoly of the manufacture of the essence. These Chinamen establish themselves during the summer in the regions where the tree grows, and remain only during the time required for extracting the essential oil. They are mostly natives of the province of Kouang-si, and bring with them the necessary apparatus, or at least a kettle, deriving the other portions of their still from the neighborhood. The essence having been acquired, they go by way of That-ke to Canton.

A diagram of one of these primitive Chinese stills for



CHINESE STILL FOR STAR ANISE.

star anise oil is shown, and is a striking illustration of the adaptation of common materials. No doubt their rude construction is the occasion of considerable loss and that improved appliances would be used were the distillers less transitory in their habits. The essential element seems to be a shallow metal kettle or basin to withstand the direct heat of the fire. This is placed as a diaphragm in a cylindrical structure of masonry which is cemented upon its inner surface. A hood, likewise of metal, is placed loosely upon the top, and has an outside gutter to retain water and an inside gutter to collect the condensed oil. A tube of bamboo conducts cold water from any convenient source to the still head, and another carries off the oil, the support for the latter serving also as an additional cooler for the discharge pipe. We venture the assertion that in this apparatus simplicity of construction has reached its lowest limit, and is not likely to be outdone even by a Chinaman.—*Am. Druggist.*

NEW PROCESS FOR BLEACHING JUTE.

JUTE is well known as a very cheap fiber, and its employment in textile industry is consequently both extensive and always increasing. Accompanying this increase is a corresponding one in the amount of old waste jute, which can be employed for the manufacture of paper.

Up to the present time only very little use has been made of jute for the manufacture of thread and the finer fabrics, because the difficulty of bleaching the fiber satisfactorily has proved a very serious hindrance to its improvement by chemical means. All the methods hitherto proposed for bleaching jute are so costly that they can scarcely be made to pay; and, moreover, in many cases the jute is scarcely bleached and loses considerably in firmness and weight, owing to the large quantities of bleaching agents which have to be applied.

Messrs. Leykam & Tosefothal have succeeded in bleaching it and rendering the fiber perfectly white by a new process, simple and cheap, so that their method can be very advantageously employed in the paper industry.

The jute fiber only loses very little of its original firmness and weight; but, on the other hand, gains largely in pliability and elasticity, so that the paper made from it is of great strength, and not only resists tearing, but especially crumpling and breaking.

The jute may be submitted to the process in any form whatever, either crude, in scraps, or as thread or tissue.

The material to be bleached is first treated with gaseous chlorine or chlorine water, in order to attack the jute pigment, which is very difficult to bleach, until it takes an orange shade. After having removed the acids, etc., formed by this treatment, the jute is placed in a weak alkaline bath, cold or hot, of caustic soda, caustic potash, caustic ammonia, quicklime, sodium of potassium, carbonate, etc., or a mixture of several of these substances, which converts the greatest part of the jute pigment, already altered by the chlorine, into a form easily soluble in water, so that the pigment can be readily removed by a washing with water. After this washing the jute can be bleached as easily as any other vegetable fiber in the ordinary manner, by means of bleaching powder, etc., and an excellent fibrous material is obtained, which can be made use of with advantage in the textile and paper industries.

The application of the process may be illustrated by an example:

One hundred kilogs. of waste jute scraps are first of all treated in the manner usually employed in the paper industry; 15 per cent. of quicklime is added, and they are treated for ten hours at a pressure of 1¼ atmospheres. The scraps are then freed from water by means of a hydro-extractor or a press, and finally saturated with chlorine in a gas chamber for twenty-four hours or less, according to the requirements of the case. Every 100 kilogs. of jute require 75 kilogs. of hydrochloric acid (20 deg. B.) and 20 kilogs. of manganese peroxide (78 to 80 per cent.)

The jute then takes an orange color and is subsequently washed in a tank, a kilog. of caustic soda being added per 100 kilogs. of jute. The amount of alkali is sufficient to dissolve the pigment, which colors the water flowing from the washer a deep brown. After washing, the jute can be completely bleached by the use of 5 to 7 kilogs. of bleaching powder per 100 kilogs. of jute.—*Mon. de la Teinture.*

FAST AND FUGITIVE DYES.

By J. J. HUMMEL.

The Action of Light on Dyed Colors.—Dyed patterns of cotton, wool, and silk were exposed for a month (February) on the sea coast near Bombay, a test considered equivalent to a year's exposure in England. From the results produced the following inferences have been made.

On *wool* most of the natural coloring matters suffer very considerably: turmeric, orchil, catechu, and indigo carmine almost entirely disappear; camwood, brazilwood, and their allies, and young fustic are, on all mordants, much decolorized; weld, old fustic, quercitron bark, and Persian berries give fast colors (olives) on the chromium, copper, and iron mordants, but fugitive colors (yellows) on aluminum and tin; logwood gives a fast greenish black on copper, very fugitive colors on aluminum and tin, and colors holding an intermediate position on chromium and iron; madder, cochineal, lac dye, and kermes give fast colors on all the usual mordants; vat indigo blue and Prussian blue are the fastest to light among colors of this group. On *silk*, the above coloring matters show similar degrees of fastness. In some cases, however, the colors are somewhat faster on silk; for example, catechu brown and the colors obtained with brazilwood and its allies on the iron mordant. The fugitive character exhibited by nearly all the natural coloring matters when dyed on *cotton* is very marked. The exceptions are: the madder colors, especially when fixed on oil-prepared cotton, as in Turkey red; the black produced by logwood, tannin, and iron; a few mineral colors such as iron buff, manganese brown, chrome orange, and Prussian blue; cochineal and its allies, which give excellent colors on wool and silk, give only fugitive colors on cotton; vat indigo blue, again, is not so fast on this fiber as it is on wool and on silk.

A series of fast colors on wool, silk, and cotton is afforded by the artificial "mordant dyes." Among the yellow coloring matters of this class, alizarin yellows R and GGW, although not true alizarine colors, are quite equal in fastness to any of the natural yellow dyes, probably faster; truer representatives of the natural dyes (giving olives on the iron mordant) exist in galloflavin and alizarin yellows A and C, and these are of about the same degree of fastness as the natural yellows. In the group of red dyes, alizarin and its allies yield fast colors; the only dyes of this group which are somewhat behind the rest in point of fastness are purpurin and alizarin maroon. Fast blues and greens are furnished by alazarin blue, alizarin cyanin, alizarin indigo, alizarin green, and cœrulein. Further, an excellent group of coloring matters, giving fast browns and greens with copper and iron mordants respectively, is formed by naphthol green, resorcinol green, gambin, and dioxin. The only fugitive artificial dyes of this mordant dyeing class are some of the yellows, gallamine blue and gallocyanin.

The substantive or "direct" class of artificial dyes is composed in the main of fugitive dyes. Magdala red on silk appears tolerably fast, and on cotton indophenin, paraphenylene blue, cinereine, and Meldola's blue, are a little faster than the rest. Biebrich scarlet, brilliant crocein, and other azo scarlets, crimsons, and clarets show a considerable degree of fastness on wool and silk, as also do crocein orange, aurantia, orange crystal, tartrazin, milling yellow, and Palatine orange on wool, and acid yellow D, brilliant yellow, azo acid yellow, metanil yellow, curcumin S, and others on silk. It is interesting to note the decidedly fugitive character on silk of tartrazin, aurantia, orange crystal, etc., as compared with their great fastness on wool. All the "acid" greens and blues are fugitive both on wool and on silk; patent blue appears slightly better than the rest. Of the "acid" blacks and violets, etc., a few colors are of medium fastness both on wool and on silk, namely, naphthol black, naphthylamine black, resorcinol brown, fast brown and one or two others.

In the benzidine class of colors, amid a number of very fugitive dyes, there are a few of satisfactory fastness: diamine fast red, for example, is quite remarkable for its fastness both on wool and on silk, and may certainly rank with alizarin; but on cotton it is quite as fugitive as the rest. Of medium fastness on wool are brilliant congo G and R and congo G R; and on silk, diamine scarlet B, deltapurpurin 5 B, and brilliant congo R. On cotton the yellows of this class appear to be the fastest, but are only of medium fastness; mikado orange R, 4 R, G, Hessian yellow, curcumin S, chrysophenin. On wool, benzo orange, congo orange R, chrysophenin G, chrysamine R, and brilliant yellow, are moderately fast.

On silk some of the fastest yellows and oranges obtainable from any source on this fiber are yielded by congo orange R, chrysophenin G, diamine yellow N, brilliant

yellow, curcumin W, benzo orange, Hessian yellow, chrysamin G and R, cresotin yellow R and G, cotton yellow G, and carbazole yellow. Few colors among the "congo" violets, blues, and purples are found worthy of particular notice for fastness; diamine violet N appears, perhaps, of medium fastness on wool and silk, while sulphonazurin, benzo black blue, and direct gray may claim the same distinction on silk.

The intensity or depth of a color has considerable influence on its fastness. Dark full shades invariably appear faster than pale ones produced from the same coloring matter, simply because of the greater body of pigment present. A pale shade of even a fast color like indigo will fade with comparative rapidity. The fugitive character of many of the coal tar colors is, in the author's opinion, rendered more marked, because, owing to their intense coloring power, there is often such an infinitesimal amount of coloring matter on the dyed fiber.

The author's opinion, based upon general observation, is that a fugitive color is not rendered any faster to light by being applied along with a fast color. When light acts upon a compound color, the unstable color fades, while the stable color remains behind. A woaded color, for example, is only fast in respect of the vat indigo it contains.

The Action of Milling on Colors.—Fast to milling, especially with respect to bleeding, are all those phenolic coloring matters of which alizarin may be taken as the type. These do not bleed because in the dyed fibers they form, in combination with the mordants, an insoluble precipitate which is largely inclosed within the substances of the fibers. That portion of the precipitate which lies on the surface is undoubtedly removed mechanically during the milling process; but even then, since the coloring matter is combined with the mordant and is not in the free state, it cannot combine with the mordants of neighboring dyed fibers, nor can it be attracted by and stain unmordanted white fibers. Phenolic coloring matters, however, are liable to bleed if they be improperly applied.

Coloring matters of the triphenylmethane group, azo scarlets, nitro dyes, and some other basic and acid coloring matters, nearly all bleed during milling. The dyed colors themselves, perhaps, are not materially impoverished, so that a plain dyed fabric might be milled with impunity, provided the soap used be not too alkaline; nevertheless, such coloring matters are practically useless for tweeds and the like, where variously colored fibers are interwoven. It is interesting to note, however, that many of the "direct" dyes are perfectly fast to milling. Even in the triphenylmethane group there are a few specially remarkable exceptions to the rule; for example, Victoria blue and night blue. Members of the eosin group are also generally characterized by their fastness to milling. Most noteworthy for fastness to milling is the whole group of "congo" dyes. This fastness, however, only extends to wool. Any white cotton fibers in the fabric milled would certainly be stained.

Many "direct" dyes, more particularly those of the "acid" class, have the defect of being greatly impoverished in color during milling, even to the point of almost total extinction. Examples of this class are acid magenta, azo scarlets and oranges, indigo carmine, etc. In the cases referred to the color is partly or entirely restored by passing the milled piece through dilute sulphuric or acetic acid. The reason of this decolorizing action is very evident. The alkali of the soap neutralizes the "color acid" on the dyed fiber, and produces a pale-colored, or even colorless, alkali salt of the color acid. The restoration of the color during the subsequent passage through acid is due to the decomposition of the colorless alkaline salt, with the liberation of the original highly colored color acid.

Some colors, both such as are dyed directly or even with the aid of mordants, have the defect of being entirely altered in hue during milling; thus cochineal scarlet becomes crimson, orchil purple becomes violet, turmeric yellow becomes brown, and so on. Here, again, the alkali of the soap either dissolves or decomposes the lake, or it combines with the coloring matter to form a differently colored compound.

The Action of Scouring on Colors.—When wool has been dyed in its loose, unspun condition, it is dried and impregnated with oil to facilitate the carding and spinning processes. The yarn or cloth made from such dyed fiber has therefore to be submitted to the operation of scouring, in order to remove the oil of the spinner. It consists in washing the material in a warm solution (50°—60° C.) of soap or carbonate of soda, or a mixture of the two, until the oil is entirely removed. The stronger alkali, and the higher temperature employed, cause the operation of scouring to be even still more searching on dyed colors than that of milling. Those colors which are altered in hue, decolorized, or impoverished in color by milling are much more altered by scouring. Some—for example, Prussian blue—are entirely decomposed.

Very susceptible to the action of scouring are the sulphonic acid colors, and, indeed, for the same reasons as are explained above. Fast to scouring, as a rule, are the "mordant-dyes," the eosins, congo colors, and some others.

All colored goods should be washed or scoured at a low temperature, and with a soap which is as neutral as possible.

Action of Stoving on Dyed Colors.—In some instances dyed colors must be fast to what is known as the operation of "stoving." Such is the case, for example, with those colored yarns which form the striped headings of blankets, with many kinds of woolen hosiery, etc. In goods of this kind, white and dyed fibers are interwoven or even spun together, and the materials are submitted to a final bleaching with sulphurous acid, so that the white fibers, which have become soiled during the spinning and weaving operations, shall ultimately appear in all their original purity.

Many "acid" and "mordant" dyes withstand this stoving operation, but others are more or less altered in color, or are entirely decolorized, either because the coloring matter is reduced or the color lake is decomposed, by reason of the acid vapors.

Action of Acids on Dyed Colors.—Fastness to acids is required from the colors on cotton yarn intended to be woven with white woolen or worsted weft, which is subsequently dyed with acid colors. Further, the color of all materials intended to be worn next the skin should be fast to acids, since perspiration contains such organic acids as acetic acid, butyric acid, etc., and although the acidity of perspiration is slight—indeed it is sometimes alkaline—still it can exercise considerable influence on dyed colors, in consequence of the additional action of friction and heat, and by its concentration upon the fiber.

Fast to acids are many of the "mordant" dyes, and also those colors which are dyed in an acid bath, provided the acidity be not too great. Basic colors, and most of the "congo" colors, are very sensitive to acids.

The Rubbing off of Dyed Colors.—No color can be considered fast if it has this defect, and yet, strange as it may appear, indigo, one of our fastest dyes in other respects, is particularly unfortunate in this one.

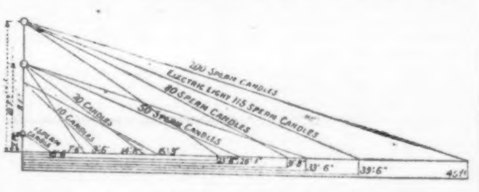
Of defective coal tar colors in this respect, malachite green and Victoria blue may be mentioned; indeed, all the basic dyes show the defect more or less, especially if they be heavily dyed. Acid colors and congo colors, as a rule, are free from the defect. On the other hand, even mordant dyes are liable to rub off if they be improperly applied.

Not unfrequently, in the case of wool, the fault is due to insufficient scouring, the employment of hard water, or from some similar cause, the fiber becoming permeated or coated with lime soap or with grease in some form or other, which either fixes the dye on its surface or prevents the effectual penetration of the mordant or dye solution.—*Jour. Soc. Arts.*

REFLECTORS FOR STREET LIGHTS.

AT the meeting of the British Association of Gas Managers, in 1879, Mr. W. Sugg read a paper on "Lighting by Gas and Electricity," in which he remarked that, when returning to the first principles of street lighting, the standard that suggests itself is the old-world spectacle of a man lighting his way with a lantern held in front of him by a stick. He said:

The height of the lantern from the ground is just 2 ft. to the center of the flame. If the lantern is provided with a parliamentary standard candle, it will, in the position I have stated, light a circle of 4 ft. in diameter. The amount of light anywhere on the edge of this circle will be sufficient to enable a man with good eyes to read a leading article in the *Times* newspaper lying on the ground. This light will just enable a man to see his way before him as he walks. In a well lighted neighborhood, where the local authorities allow to each lamp 5 cubic ft. of gas per hour, and there are no shops, this is the average kind of light which is found at 7 ft. 6 in. from the lamp post. The lamp is 10 ft. from the ground. . . . I have here a diagram which will show the effect of the present as well as of the improved gas lighting, and the effect also of the electric lighting for streets. Besides this, it



affords a guide by which you may be able to arrive at some practical conclusions as to the proper height of posts in regard to the light in the lantern. You see that as the height of the post is increased, so the illuminating power of the lamp must be increased also. The diagonal lines in the drawing show where the standard light of one candle is given. This diagram is intended to show where the standard amount of light will be given on the ground by street lamps of the power of 10, 20, 50, 80, 120, and 200 candles; it will also show the most suitable height of post for these different burners. The lowest spot on the vertical line which represents the post is 2 ft. from the ground; the next highest spot is 10 ft. from the ground; and the highest spot is 15 ft. from the ground. This is the height of the columns on which the electric light is fixed in the Avenue de l'Opera.

Now let us make an application of this diagram to practice. A 5 ft. per hour ordinary street gas lamp gives the standard of light of one candle carried by the pedestrian, at 7 ft. 6 in. from the lamp post. It is, therefore, clear that 10 ft. is too high for such a weak light. On an 8 ft. post, the same light will give us the standard light on the ground at nearly 10 ft. from the post; a 20 candle burner will give us the standard light on the ground at 14 ft. 6 in. from the post; a 50 candle burner, at 26 ft.; an 80 candle burner, at 33·6 ft.; an electric light, at 39·4 ft.; and a 200 candle burner, at 54 ft. All these are direct rays, without reflector of any kind. If a good white glass reflector be put over the gas burners, they will give at least 50 per cent. more light, and the distance to which they will send the standard quantity of light will be one-quarter of the horizontal distance more than without the reflector.

REPORT ON SOLID EMERY WHEELS.

THE emery wheel is in such general use in the machine and repair shops of industrial establishments that peculiar interest attaches to a report recently made to the Tanite Company, of Stroudsburg, Pa., by Messrs. Coleman Sellers, J. E. Denton and Alfred R. Wolff, upon the comparative value of fifteen varieties of solid emery wheels of different makes, which were purchased independently by them and submitted to exhaustive trials, covering a great variety of conditions and extending over a considerable period of time. We learn from the report that "among these fifteen varieties only one compared favorably with the Tanite wheel, the latter having easily beaten all competitors save one. The comparative values of the Tanite and its one rival will have to be ascertained by further trials."

The report states in detail the steps taken to insure valid results from the investigation, and we make the following extracts, showing, so far as our space will admit, the methods employed and conclusions reached:

"It was agreed that to constitute a good solid emery wheel, the follow qualities should be combined: Safety under the widest conditions of use or misuse; rapidity of cut; freedom of cut at moderate pressure; reasonable amounts of wheel loss and power consumption; evenness of wear; general staying quality; and reliability under the widest range of circumstances.

"Our board then agreed upon a programme of work—had the test machine erected in the machine shop of the Stevens Institute of Technology at Hoboken, N. J., and had the various wheels (bought directly by themselves) delivered there. The grinding was done on cast iron bars supplied directly to us by one founder, special care being taken as to quality of metal and size of bar. The trials reported on were made at the Stevens Institute during 1889 and 1890, the tabulations being too voluminous to admit of detail here.

"Of the fifteen varieties, six were found too unsafe to warrant their general use, 57 per cent. of the wheels bursting under the same conditions which other wheels passed through uninjured. Eleven varieties (among which are included the six unsafe varieties) were found to be such slow cutters that the average metal removal of ten of them was less than the general average of all the wheels. Of the fifteen varieties, only four were found to be rapid cutters. Of these, one wore so rapidly that the cost of its rapid cut was unreasonable. This left three safe, effective and satisfactory wheels, one of which, however, was demonstrated to work at a greater cost than the Tanite. The rivalry was thus narrowed to two wheels, and, in the judgment of our board, further trials are necessary before the relative value of these two can be determined.

"Our investigation satisfied us that the ordinary user of solid emery wheels is likely to be deceived as to the productive capacity of such wheels and the cost of product if he trusts to mere appearances, and that the real value of any solid wheel can only be fixed by an investigation which gives exact data and covers a wide range of observation.

"This investigation demonstrates the unquestionable superiority of the Tanite wheel to thirteen out of fourteen competitors.

"As nearly all the preliminary and collateral trials were made with Tanite wheels, more than three times as many of these were used as of any other make. In all this use, under every degree of measured automatic pressure and under the heavy pressure of long bars used by hand and also at a speed nearly double that of any other wheel save one, no Tanite wheel burst. The safety of the Tanite wheel can be considered unquestionable. The Tanite wheel never deteriorated with use, its average last cut always exceeding its average first cut. The Tanite wheel cut well at moderate pressure, and in using it the workman's task is an easy one.

"The consumption of power and of wheel material is such that, taking into account the cost of labor and all other items entering the problem, the Tanite wheel does its work at a very low cost.

"In the use of all tools and machines, consideration should be given to their regularity and uniformity of action and to their freedom from such stoppages as arise from a variety of undefined and unforeseen causes. From a great variety of causes many of the competing wheels failed to complete their series of trials and gave rise to frequent incidental stoppages. Such was not the case with the Tanite."

THE REFINING OF PETROLEUM AND LUBRICATING OILS.

PETROLEUM and lubricating oils obtained by the distillation of mineral oils are generally refined by treatment with sulphuric acid and caustic soda, followed by washing with water. Sulphuric acid at 66° B. is mostly employed, the amount used ranging from 2 to 4 per cent. for petroleum to 5 to 10 per cent. for lubricating oils. The acid is well agitated with the oil, either all at once or preferably in several installments, the acid being allowed to settle thoroughly after each treatment. The acid combines with and dissolves the olefines and aromatic hydrocarbons contained in the oil, and an oxidizing action also appears to take place, indicated by the evolution of sulphurous acid. This latter action increases with the specific gravity and temperature of the oil, so that it is well to keep the mixture cool. The time of treatment varies from one to two hours, the operation being finished when a sample of the oil shaken with caustic soda solution appears milky and white or only slightly yellow (petroleum), or when the original green brown color has changed to violet red (lubricating oil). The loss during acidification is from 1 to 3 per cent. for petroleum and 8 to 15 per cent. (seldom 20 per cent.) for lubricating oil.

The oil is next washed with water and well agitated with a caustic soda solution at 30° to 33° B. The intermediate washing is best omitted in the case of lubricating oils, since it leads very often to the formation of emulsions, which are separated from the oil with great difficulty. The treatment with soda is continued for 5 to 10 minutes at the ordinary temperature in the case of petroleum, while with lubricating oil the action is carried on at 40° to 60° C. until the violet color of the oil is changed to a wine yellow tint. The consumption of soda lye at 33° B. is about 1 to 1·5 per cent. Too long a treatment with soda must be carefully avoided in order to prevent the extensive oxidation of the oil and the consequent production of the sodium salts of organic acids.

The salts are partially saponified during washing, the acid liberated being dissolved by the oil and leading to turbidity in the finished product. The oil, after being separated as completely as possible from the lye, is washed with cold water (for petroleum), or with water at 60° to 70° C. for lubricating oil) until perfectly neutral. Thorough washing is of the greatest importance. Petroleum containing sodium salts in solution burns badly owing to the incrustation that soon forms on the wick, besides which sulphurous acid is given off if sulphates, etc., be present. The water should be as free from dissolved salts as possible, especially for washing lubricating oils.

After washing, petroleum is left in the reservoirs for 12 to 36 hours, so that the last traces of water may settle. Or, after standing for an hour, it may be filtered through a mixture of wood shavings and salt. In either case the oil will be ready for the market. Lubricating

oil is kept in a vessel heated by steam until the bulk of the water has settled. It is then transferred to a shallow double-bottomed pan and "boiled" by steam until it is quite bright and clear, and no longer froths. In many cases the oil is, after boiling, filtered through animal charcoal, etc.

The apparatus in which the oils are chemically treated may be divided into two groups: 1. Those in which some mechanical stirring apparatus is employed. 2. Those in which agitation is effected by a strong current of air entering the bottom of the apparatus. The author is strongly of opinion that those of the first class are much to be preferred. Agitation by means of air currents is certainly more thorough than by any mechanical device; but when the ready oxidibility of petroleum, and more particularly of lubricating oil, and the injurious influence of the acids so produced are considered, it will be seen that mechanical stirring arrangements are really the more advantageous. In the case of air agitators there is also a much greater tendency toward emulsification, which is very objectionable. The turbidity appearing in finished petroleum, etc., is chiefly due to the presence of organic acids and salts, which gradually separate. The turbidity which badly refined oil sometimes develops in barrels is most likely caused by the action of organic acids on traces of chalk contained in the glue with which the interiors of the barrels are coated.—*Chem. Trade Journal.*

MANUFACTURE OF POWDERS AND NITRATED EXPLOSIVES.

THE manufacture of nitrated explosives and smokeless powders has assumed such proportions that it has become necessary to pay very particular attention to the preparation of the crude materials, and especially of the acids concentrated to the degree required by a proper nitrification. Moreover, the ever-increasing competition of the various works has obliged the manufacturers to seek a means of diminishing net costs through the recuperation of the sulphuric and nitric acids that have served for the preparation of nitro-glycerine and the nitro-celluloses and through the utilization of the by-products.

The progress that has already been made in this direction is very important. We shall point out more particularly the new processes of concentration of sulphuric and nitric acids, the separation of the acids from the sulpho-nitric mixture and the utilization of the by-products in the manufacture of nitric acid.

I. CONCENTRATION OF SULPHURIC ACID BY THE NEGRIER PROCESS.

The sulphuric acid that comes from the lead chambers stands at about 53° B. and contains 33 per cent. of water by weight. In this state it is unfit for commercial and industrial purposes. If it is desired to use it in dynamite and gun-cotton manufactories, it is necessary to concentrate it to 66° B., and it will then contain from 95 to 99 per cent. of monohydrate, H_2SO_4, according to the atomic formula.

The work comprises two successive operations. In the first, it is brought to the degree 60, say 78 per cent. of monohydrate, by a simple evaporation in the open air in large leaden basins, with flat bottoms, united in stages. Then the concentration is finished to 66° B. in platinum vessels.

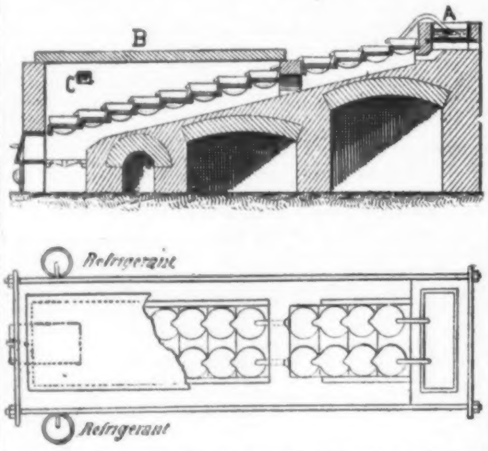
We all know the inconveniences of these platinum vessels, which, moreover, are very costly and necessitate the locking up of a large amount of capital, the smallest of them being worth $5,000. Now all the attempts made up to the present to substitute more practical apparatus for them have failed, and it was not till the present year that Mr. Charles Negrier, after numerous experiments, succeeded in constructing a simple, economical furnace, which concentrates sulphuric acid as well as the platinum retort does, and which will find a place in all small manufactories of chemical products and the manufactories of dynamite and the nitro-celluloses (gun-cotton, soluble nitro-cellulose, collodion).

In the new arrangement the platinum vessel is replaced by a series of hard porcelain capsules capable of withstanding the briskest fire. These are arranged in stages one above the other, and the acid, which enters the uppermost at 60° B., slowly flows into the following, so that, on making its exit from the lowermost, it is concentrated to the desired degree. These capsules, whose diameter is 12 inches, are 6 inches in depth. They are supported in pairs by slabs of cast iron or refractory clay, provided with depressions into which they are set with a play of about one-fifth of an inch.

furnace is shown in Figs. 1 and 2, which give a longitudinal section and plan of it.

A complete furnace comprises 16 capsules for the concentration, 8 for a preliminary heating in the open air, and a leaden reservoir, A, arranged on the passageway of the still hot gases that are flowing to the chimney. The acid entering this reservoir begins to concentrate and afterward flows into the capsules where first heated, through a siphon whose discharge is regulated according to the conditions of the furnace's work, and already stands at 60° B. when it reaches the concentrating furnace properly so called. The acid vapors formed in this part of the apparatus escape into a flue, C, formed in a plate, B, of cast iron, which closes the evaporating chamber.

There is employed by preference a slab of Volvic stone, since cast iron would be attacked in the long run and would give sulphate of iron, which would contaminate the acid. Although this slab is always quite



FIGS. 1 AND 2.—SECTION AND PLAN OF THE NEGRIER FURNACE, FOR CONCENTRATING SULPHURIC ACID.

hot, in order that no condensation may take place, it is nevertheless a good precaution to give it a slight inclination in order to favor the flow of the liquids resulting from accidental condensations and to prevent them from falling into the concentrating capsules.

As the two groups of capsules situated immediately above the grate are more exposed than the others to breakage or cracking, they are placed upon slabs of refractory clay, whose expansion is not so unequal as those made of cast iron.

The first basin-like supports contain apertures which give the hot gases from the furnace a more immediate access to the bottom of the capsules, and which, at the same time, facilitate the flow of the acids when a breakage occurs. Those which are most distant from the fire, and upon which the action of the flames is less to be feared, have no bottom, and the corresponding capsules are heated directly.

The cast iron and fire clay slabs are provided with flanges, which are juxtaposed, and prevent the gases from the furnace from entering the chamber of acid vapors. Precaution is taken, moreover, to perfect the joints by means of a luting of asbestos powder or of silicate of soda and asbestos powder.

When a capsule breaks, the liquid that it contains flows into the furnace, where its presence is immediately made known. The supply is then shut off and the broken capsule is replaced. The operation requires but from three to four minutes at the most, and it is useless to deaden the fire. This accidental fall of acid upon the grate is attended with no danger.

The capsules of the first heating do not rest upon iron basins, but are simply placed in depressions formed in the supporting slabs, and consequently undergo, directly, the action of the hot gases that have already circulated under the concentrating capsules.

Each group of porcelain capsules is separated from the neighboring group by the flanges of the supporting slabs. Besides, they are all enveloped in fine packed sand, which isolates them from each other. With such precautions, we have no fear of any prejudicial contact that might result from unequal ex-

we have just described gives results that are truly remarkable. In 24 hours it furnishes from 2,420 to 2,860 pounds of acid at 96° in weight of monohydrate, with a consumption of coal not exceeding 480 pounds.

The apparatus may be doubled, or four furnaces may be placed back to back. The effect obtained in the latter case is that that would be obtained by condensation in a platinum retort weighing 55 pounds.

Fig. 3 shows the arrangement of a quadruple furnace.

A fireplace may be employed for each furnace, or simply one fireplace per group of two furnaces.

Whatever be the arrangement adopted, the acid at 53° B. is let into a large central leaden reservoir. Thence it is distributed, by means of hard rubber valves (or by any other means), to four receivers, corresponding to each of the four furnaces. It afterward flows through siphons into the series of capsules of the first heating; but care must be taken to regulate each siphon separately. Finally, such liquid as has been concentrated to 66° B. is collected in a leaden refrigeratory, wherein it is allowed to cool. This operation presents no difficulty, since 66° sulphuric acid at a temperature of 100° C. scarcely attacks lead.

A single chimney suffices for the quadruple furnace. This carries off the gases from the fireplace after they have heated the five leaden receivers above mentioned. Under such conditions, the heat is well utilized, and losses through the chimney are reduced to a minimum.

A breakage or even a simple cracking of the capsule is made known through the appearance of vapors above the grate, or through the stopping of the flow of acid into the refrigeratory. To remedy this, the feeding through the siphons is arrested, then the slab that covers the concentrating chamber is lifted, and the broken capsule is replaced. The operation is extremely simple, especially if we compare it with that necessitated by the repair of platinum retorts, in which a simple soldering has to be effected with pure gold, and requiring a complete stoppage of the works.

Breakage, however, does not often occur, and when the operations are well conducted, it is, in fact, extremely rare. However, it is well to stop the operation of the furnaces every two or three months in order to make a thorough examination of their various parts.

In short, the Negrier concentrating apparatus presents the following advantages: (1) Its operation is continuous; (2) it is capable of yielding, through a simple regulation of the siphons, acid concentrated to different strengths, comprised between 53° and 66° B.; (3) the expense of maintenance and repairs is very small; (4) its installation is very simple and very cheap, since it corresponds to a total cost of about $100.

At present, this furnace is in use in the Maletre and Saint Gobain works in France, in the dynamite works of Villefranca-in-Lunigiana in Italy, in the Belgian works of Droogenbosch and De Monstiers, and finally, in the Nobel dynamite works at Bilboa.

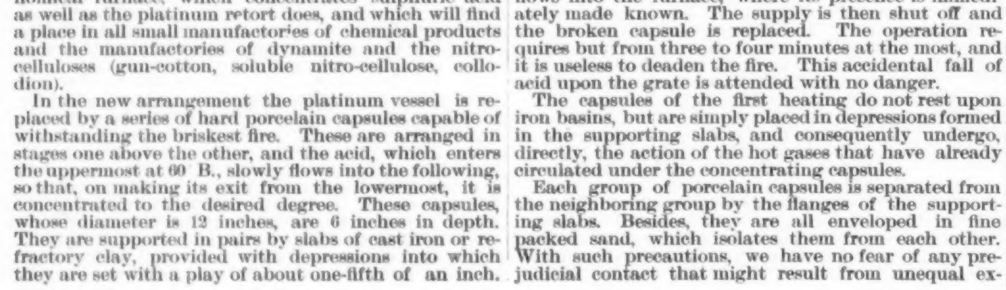


FIG. 3.—FOUR FURNACES PLACED BACK TO BACK.

A, central acid reservoir; *a a a a*, acid distributors; *b b b b*, covers of concentrating chambers; *c c*, refrigeratories.

In order to prevent the breakages that might occur from sudden and repeated shocks, a protective layer of asbestos cloth or fiber is interposed between the capsules and their slab. Care is taken, moreover, to place fragments of porcelain in the capsules for the purpose of diminishing the dancing that the ebullition never fails to produce.

The fireplace is located beneath the last capsule, and the flames, which circulate under the various steps of capsules, do not escape into the chimney until after having been utilized for raising the temperature of the acids that are to be concentrated.

The general arrangement of an improved Negrier

pansions in the various heterogeneous parts of the apparatus.

The entire masonry of the acid chamber is of bricks, upon which rests a slab of Volvic stone. Laterally there is formed a suction flue into which debouches a lead pipe designed to remove and condense the acid vapors.

The economy of the Negrier furnace comprises, then, three successive operations: (1) Heating of the acid, at 53° B., in the leaden chambers; (2) concentration to 60° B.; (3) concentration to the industrial degree of 66° B.

The 24 capsule apparatus and leaden reservoir which

COLOR IN PHOTOGRAPHY.

IF there is any problem that has tried the acuteness of investigators, it is indeed that of the photographic reproduction of the colors of nature. As has been recalled in these columns, in a historical summary, some, such as Cros, Ducos de Hauron and Leon, to mention our compatriots only, have endeavored to solve the difficulty by a proper separating of the colored rays, and have obtained negatives of the same subject, each containing only the impression given by one color. They have printed monochrome film positives, which, through superposition, have furnished tints, if not always accurate, yet at least very near those of the model. As long ago as 1848, Becquerel, through chemical means, reproduced the entire solar spectrum, but the print did not withstand white light, and no means of fixing permitted of preserving, in the full light of day, the magnificent results obtained. Mr. Lippmann very recently resumed this study, and taking theoretical conceptions as a basis, solved the problem anew, and his brightly colored solar spectra withstand the light of the sun without alteration. I shall not dwell upon this process, which has already been described in detail in this journal, but shall merely state the fact that Mr. Lippmann was the first to point out that the solution of the question could be obtained through interferences.

Now it is through a process that proceeds from a principle of the same nature that Mr. Baudran, an engraver of Versailles, found, some twenty years ago, in silver positives on albumenized paper, the trace of natural colors; but, before describing the curious experiment made by him, let us be permitted to briefly recall the observations that had already been made, and which constitute a preliminary step toward this discovery.

It is beyond doubt, at present, that objects have no individual color, and that the latter resides essentially in the subjective sensation of the vibratory mode or rather of the wave length of the vibration of the ether, reflected by such objects. To the greatest wave lengths corresponds the sensation of red, and to the shortest, that of violet. The reunion of all the rays of different wave length produces white light.

If, on another hand, the latter chances to be refracted upon a finely striated surface, it becomes decomposed, and the surface seems to take on all the colors of the rainbow, by virtue of a phenomenon known in physics under the name of diffraction.

If, for example, we look at mother-of-pearl at right angles, it appears of a milky color, while under a certain incidence it assumes the brightest and most varied colors. It is very easy to prove that these colorations do not belong to the mother-of-pearl, but are due to the arrangement of the asperities of the surface, since if by some physical or chemical process we destroy the superficial layer, the brilliant colors disappear. Inversely, let us apply a fragment of iridescent mother-of-pearl to melted black sealing wax and detach it after cooling, and we shall find that, owing to its plasticity, the wax has taken an exact impression of the infinitely fine striæ of the shell's surface, and will in turn assume the most marvelous colors. This experiment, which is due to Brewster, succeeds, as he has demonstrated, with all substances that are capable of being moulded faithfully upon the mother-of-pearl, such as lead, realgar, tin, etc. Quite an original application of this experiment was made at this epoch by

John Barton, an Englishman, who, by properly striating the facets of steel buttons, colored them with all the shades of the prism. Some thirty years ago these trinkets had the greatest success.

Now, these colors by diffraction are clearly perceived upon Daguerrean images. In fact, if we examine these at a certain angle of incidence, they are observed to assume colors which are weak, it is true, but which are easily distinguishable. It would seem as if the deposit of metallic silver or mercury must form with a fineness proportional to the wave length that leads to its precipitation. Mr. Baudran, having ascertained this on his own part, asked himself whether, in the phototype with silver salts upon albumen, the deposit of metal does not follow the same law, and in order to elucidate this point, he made use of an apparatus which is nothing more than a modification of Charles' megascope.

A photograph, a portrait card, for example, is put in the focus of a double portrait objective, and is illuminated on each side by two mirrors at an angle of 45°, which reflect daylight upon its surface. This apparatus is installed in an aperture formed in the side of a dark room, and is pointed toward the sky in order to obtain a very pure light (Fig. 1).

The enlarged image is received at right angles upon a sheet of white paper. If we observe this image attentively, after the eyes have recovered from the effect of daylight, we shall soon see the colors appear. They are then very weak and are mixed with diffused white light. If the objective be diaphragmed, the general intensity of the subject will diminish, but the colors, although always very weak, will be purer. The projection then takes on the aspect of a pastel seen in a subdued light. In order that the colors may appear, it is essential that the image shall be well modeled without being too rough, for in the latter case the accumulation of the particles of silver prevents diffraction from taking place freely. Neither positives sulphureted and made yellow by time, nor those that have been glazed or produced by the gelatino-bromide processes, give good effects. The colors that come out best are those that make the least impression upon the negative plate, the reds, for example—an effect that

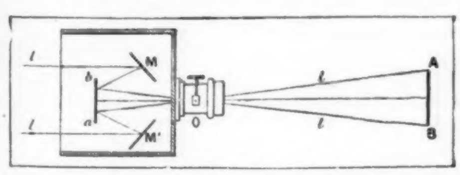


FIG. 2.—DIAGRAM OF THE APPARATUS.

a b, photograph; A B, image enlarged and reversed upon a screen; M M, reflecting mirrors; O, objective; *l l*, course of the rays.

may be readily understood, since these colors are rendered upon the positives by a greater quantity of reduced silver.

Such is the character of Mr. Baudran's researches, who gives his work the significant title of "Color in Photography." He supposes that the silver is deposited in the negative plate in a molecular state in relation with the wave length of the ray that has struck it. There results, therefore, a sort of network with variously spaced meshes whose distance apart corresponds to this same wave length, and which, separating the colored rays that constitute white light, give a deposit of the same nature upon the phototype. In the negative, as the metal is embedded in the gelatine, it is impossible to find its color, while in the positive the reduced silver is held only by a thin layer of albumen, and is capable of diffracting light. This theory would require a few contradictory experiments to demonstrate the value of it. At all events, direct experiment clearly shows colors in the projection of the positive. This is an experimental point acquired, and a most curious one.

Mr. Baudran has disclosed this discovery in a memoir addressed to the Academy of Sciences, and has added thereto some information in regard to a particular process for the reproduction of positives with the colors of the model; but as he still holds his *modus operandi* secret, *La Nature*, faithful to its habit of making known only such discoveries as are duly verified, will be content to point out the fact, and, despite some very successful copies of paintings that the inventor has shown us, we believe it our duty to wait, in order to speak more in detail of it, until Mr. Baudran judges fit to divulge his invention completely. However this may be, his first discovery, which any one may verify, suffices to prove that we have to do with an observer and an investigator from whom we may expect, in the same order of ideas, results that have been unlooked for up to the present.—*La Nature.*

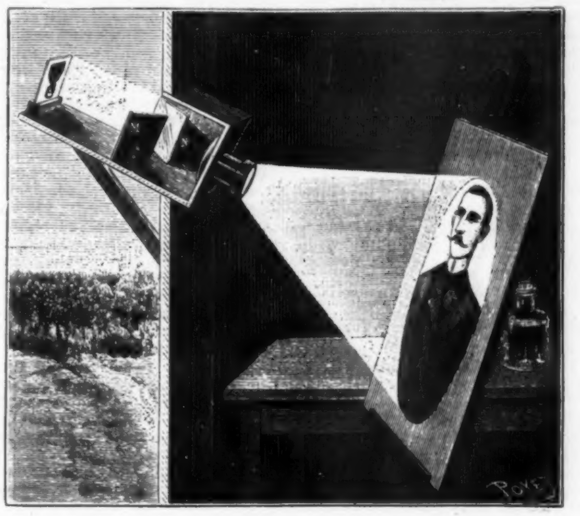


FIG. 1.—APPARATUS FOR CAUSING THE APPEARANCE OF COLORS IN A PHOTOGRAPH.

PHOTOGRAPHY IN COLORS.

AT one of the recent sessions of the French Society of Photography, Mr. E. Vallot presented a beautiful print in colors obtained directly by the aid of a process due to Poitevin, although with some variations in the formulas.

Strong photographic paper (Rives' 26 lb. does very well) is floated for five minutes on a solution (A) composed of:

Water	100 grammes.
Chloride of sodium	10 "

and is then dried as rapidly as possible. The dry paper is sensitized for five minutes in a bath (B) consisting of:

Distilled water	100 grammes.
Nitrate of silver	20 "

The paper is then allowed to drain for a few moments, and is washed with distilled water and then with running water for ten minutes. In order to eliminate every trace of free nitrate of silver, the paper is allowed to remain for ten minutes in a bath (C) composed of:

Water	1000 grammes.
Chloride of sodium	20 "

On being taken from this bath, it is washed for a few minutes under running water, and, while still wet, is placed, sensitized surface upward, in a tray containing 500 cubic centimeters of water to which is added 20 cubic centimeters of a solution (D) consisting of:

Distilled water	100 grammes.
Protochloride of tin	5 "
Sulphuric acid	2 drops.

The whole is placed in a diffused light in order to convert the white chloride of silver into violet subchloride. The insolation must be carried to dark violet. After a thorough washing, the paper is placed in darkness in order to dry.

When the drying is complete, the paper is immersed for two minutes in a mixture of equal parts of the two following solutions:

(E) Water	100 grammes.
Bichromate of potash	5 "

(F) Sulphate of copper to saturation.

After being dried, the paper is capable of giving colors. The insolation is effected in a printing frame, under glass or transparent paper.

When the paper is taken from the frame, the colors are seen, but they are obscure and dull. In order to give them all the brilliancy possible, the paper is immersed in a bath composed of:

(G) Water	1000 grammes.
Sulphuric acid	20 "

The immersion should not be prolonged out of measure in this bath, which first brightens the colors, but afterward destroys them. After thorough washing, the prints in colors are albumenized in order to give them greater brilliancy.

All the preceding operations should be performed in a laboratory lighted with yellow or red glass. The prints in colors must be preserved in darkness, since, up to the present, no method of fixing them has been found.—*Annales Industrielles.*

INFLUENCE OF TEMPERATURE ON THE COLOR OF PIGMENTS.

EXPERIMENTS BY EDWARD L. NICHOLS AND BENJ. W. SNOW.

OUR results may be summarized as follows:

1. None of the pigments tested equals the ideal white in reflecting power, even in that part of the spectrum for which its reflecting power is greatest.

2. The reflection spectrum of pigments arises from two distinct sources: (*a*) light reflected from the surface of the substance; (*b*) light reflected from interior faces. The light reflected from the surface is nearly white. Its brightness varies from about 2 per cent. (as in HgS) to nearly 10 per cent. (as in HgO). It is to the light internally reflected that the pigment owes its color.

3. The effect of heating a pigment is invariably to diminish its reflecting power, the diminution being as a rule more marked in regions of greatest refrangibility.

4. The changes of color, observable when a pigment is heated, are due to this unequal loss of reflecting power, and the effect which has been described as "a shifting of the color toward the red" arises from the fact that the loss of brightness is least in the red and increases rapidly as we pass toward the violet end of the spectrum. There are cases, however, like those of chromic oxide and the oxide of zinc, in which a shifting of a region of maximum of reflecting power toward the longer wave lengths actually occurs when the pigment is heated.

It had been our purpose in the investigation just described to extend our spectro-photometric measurements to the very low temperatures obtainable by the use of solid carbon dioxide, but we have been compelled by lack of time to content ourselves with noting such changes as could be detected with the unaided eye. The change observed was in every case that which would be brought about by increase of reflecting power. There was no increase in the saturation of the color, rather, on the other hand, a paling or dilution of the tint, as though there were a tendency toward white. Houston,* who made a similar set of observations at the higher temperatures reached by the evaporation of carbon bisulphide or sulphurous acid, arrived at a similar result. Ackroyd, from theoretical considerations, concluded that as the absolute zero is approached the prevailing tints of pigments will be blues and violets, merging finally into white.

Ackroyd, Hartley, as also Houston and Thomson, and still earlier Schoenbein and Brewster, have had something to say concerning the explanation of these phenomena. Their various views need not be touched upon here, unless it be to call attention to the opening paragraph of Ackroyd's paper, which contains an important statement. Ackroyd says: "These changes embrace a class of phenomena quite as important in their way as phosphorescence and fluorescence, *with which in fact they are intimately connected.*" It is his opinion that the connection is a most intimate one, and that every change of color that pigments undergo is to be regarded simply as a symptom of changes in the radiating power of the substance.—*Phil. Mag.*

THE ORIGIN OF DEATH.

By EDWARD G. GARDINER, Ph.D.

AMONG the most brilliant of modern biologists is to be reckoned Prof. Augustus Weismann, of Freiburg. His numerous contributions to science place him in the rank of those whose words are never without interest and value to the naturalist; but, besides his publications, which give record of long and laborious experiments and observation, he has added a series of essays of profound interest, not only to the specialist, but to every mind which takes pleasure in scientific speculation.

These essays are devoted to the discussion of a new theory of heredity; but, besides this, he advances views which to many must seem startling, viz., that death, in the sense in which we know it, did not always exist, but is something which has been acquired by the higher animals as they were evolved from the lower; and further, that individuals of a large group of animals living to-day are potentially immortal.

In one of his earlier essays he points out that the manner of reproduction among the Protozoa is such that death does not normally occur in this group; for the animal reproduces by merely dividing itself into halves. Thus an adult animal ceases to exist as such by becoming two animals instead of one. It does not die during this process, for there is no corpse; but the whole animal, as such, has completely disappeared, and in its place we find two individuals so similar that it is impossible to regard them as parent and offspring. Indeed, they cannot be parent and offspring, for they are of the same generation; it is more natural to call them twins. They are both young animals, for they increase in size; and when adult, each of them ceases to exist by dividing itself into two new young ones, and so on indefinitely.

Hence it would appear that the life history of such an animal may be divided into two periods—youth and adult life. There is no old age; there is no death. Clearly, then, since these forms do not die, they may be said to be potentially immortal. The living matter of which they are composed passes over without break into a younger generation, and in it life is continued. These facts have been long known, and earlier investigators have pointed out the potential immortality which this mode of reproduction implies; but Weismann was the first to develop this knowledge into a scientific theory which may throw light on other facts.

When Weismann calls these animals immortal, he draws a proper distinction between the terms immortal and eternal. Eternity reaches back into the past, as well as out into the future. With eternity he has nothing to do. Neither does he use immortality in the sense in which it is used in theology—as applied to something which can never die, but must exist through all future time. His claim is not that the life of a Protozoon is such that it must under any circumstance exist forever, but that it will exist as long as proper physical conditions exist; that death is not inherent in life.

He compares the life cycle of a Protozoon to the circulation of water, which evaporates, gathers in clouds, and falls to the earth, only to evaporate again. And there is no inherent cause in the physical and chemical properties of water which will bring this cycle to an end. As long as the present physical conditions exist, the cycle must continue. So it is, he claims, with the life cycle of a Protozoon; *i. e.*, division, growth by assimilation, division again—and so on without end; there being no inherent cause in the constitution of the protoplasm which will cause it to fall short of its cycle and physiologically decline in fertility and vigor. He does not mean that such unicellular forms cannot be starved to death, crushed out of existence, devoured, or killed by disease. These are rather accidental than natural deaths. Neither would he claim that in no case have individuals by insufficient nutrition or unfavorable surroundings acquired the seeds of death, so that their race has been limited, and finally become ex-

* *Loc. cit.*, p. 123.

tinct. This again is accidental rather than natural death. He claims only that since life has existed in these forms, it has passed unbroken from one generation to another down to to-day. The material of which the individual is made may change, but in all cases it is animated by the same life.

Now no one doubts that the Metazoa have at some time in the remote past been evolved from such potentially immortal Protozoa. But the life of all of the Metazoa may be divided into *three* periods—youth, adult life, and old age, during which latter there is clearly a physiological decline in vigor, which is terminated normally by death.

Old age and death then would appear to be something which have been acquired with the development of the Metazoa from the Protozoa. Exactly for what purpose, and how, death has been instituted, are questions which Weismann endeavors to answer.

But first let us compare the life history of a Metazoon with that of a Protozoon, and see whether there is anything in the Metazoa which is comparable to Protozoon immortality. All Metazoa start their individual lives from an ovum, which is a single cell, and may well be compared to a Protozoon. After fertilization this cell or ovum divides into two, then into four, then into eight cells, and so on, thus giving rise to a very large number of cells, which, as development progresses, differentiate to form the tissues and organs of the embryo. Now of these cells in the embryo Weismann distinguishes two different kinds, viz., the germ cells, which lie in the generative glands of the animal, and the somatic cells, which form all other organs and the body itself. During early youth the germ cells remain dormant. When, however, adult life is reached, they develop, and under proper conditions, such as fertilization, etc., each one is capable of producing a new organism, with germ cells and body, while the body itself grows old and dies. The germ cells of the second generation do not die, but produce a third, and the third a fourth generation, and so on. The body of each of these generations must grow old and die, but the germ cells themselves, if allowed the proper physical surroundings, do not. They go on germinating, and so produce generation after generation.

Hence it would appear that the germ cells of the higher organisms are exactly parallel to the entire body of the lower forms, and like them are endowed with potential immortality, and that this immortality has never been broken by death since life first existed on this earth. In other words, a Metazoon equals a colony of Protozoa plus a perishable body.

Death, then, is something secondary; an adaptation which has been acquired during the evolution of the mortal from the lowly immortal forms.

Weismann suggests that this adaptation of death has been brought about in the following manner, by what he terms *panmixia*, or the cessation of natural selection. It is generally admitted that congenital variation in the size and form of every organ or part occurs constantly, and further that such variation is liable to be inherited; also that species are formed and maintained by natural selection preserving the most favorable variations. For instance, the large and powerful wings of wild ducks and geese are an absolute necessity to them, not only to escape enemies but to migrate from the sub-tropics to the arctic zone as the change of climate and scarcity of food necessitates. With weak wings, a wild duck or goose would have but poor chance of competing with its companions in the stern struggle for existence which is a part of its life. In the stormy northern hemisphere in which most of these birds breed, strong powers of flight are of vast advantage, and when the time for migration comes, an absolute necessity.

Now if some of the young of these birds vary even a little from the parental type, and have even stronger wings than the average, so much the more fortunate they; if, on the other hand, the wings are below the average, there is just so much less chance of their accomplishing the migration safely and returning another year to breed and transmit to their offspring their short-winged peculiarity. In these birds it would seem that natural selection compels strong powers of flight, and that the strong wings which characterize them are maintained by a survival of the fittest. This is a well-known law.

Now without doubt the domestic ducks and geese are descended from wild forms; yet they fly but poorly. Indeed, actual comparison shows that the wing bones are smaller in the domestic than in wild ducks. But in domestic ducks the power of flight is but little used. It is of no advantage to it to fly far and fast, and hence in these forms the young with small wings would be apt to survive and transmit their individual variation as would the long-winged ones, and as a consequence of this free interbreeding of the long and the short winged, the general average of length of wing would deteriorate. In other words, natural selection would cease to compel long wings, and *panmixia*, or the "mingling of all," would allow them to degenerate. There are several kinds of wild bird—the dodo, penguin, apteryx, ostrich—incapable of flight, and all doubtless descended from birds with functional wings. This may be accounted for if we can suppose that gradually the ancestors of these forms, by change of habit, climate, or surrounding conditions, were able to obtain their food with but slight use of the wings. Then the survival of only the strong of wing would cease, and *panmixia* would cause the wings to degenerate.

Without doubt the eyesight of animals which live in the light of day is maintained in its perfection by the action of natural selection. Take, for example, the birds of prey, such as the eagle or vulture, which have exceedingly keen sight, by means of which they detect their food at great distances. A near-sighted vulture would have but poor chance of competing successfully with its more fortunate companions. Another example may be found among savage races of men. It is often asserted that the North American Indians have eyesight keener than that of most white men. To the Indian this sense is of as much importance as to the vulture or eagle, for like them he is dependent on the chase for his livelihood. A myopic or weak-sighted Indian could rarely survive to transmit his weakness to the race. In both these cases the keen sight has been produced by a survival of only the fittest; and if this natural selection were removed, the result would be a reduction in the power of the organ in question. We are, of course, descended from keen-sighted savages, but civilization has introduced other means of support, in which the myopic individual stands on equal terms with the man of normally, or even abnormally, good sight. Here again *panmixia* has caused an organ to degenerate.

Similar cases are to be found among animals which live in subterranean caves where total darkness prevails. Some of these caves have existed since the Pliocene period, and it is probable that their present inhabitants, insects, crustacea, amphibia, and fish, have lived and bred there for thousands of generations. Many of these are blind, having but rudimentary eyes. Some are also colorless. Now to animals living in the light of day, color is either protective, or of some advantage; therefore it is maintained by natural selection. But if congenital variation should produce animals with less vivid hue, these would, of course, survive in total darkness as well as their more brilliant brethren; and by breeding with them, the colors of all would gradually be reduced.

And so with their eyesight. What advantage is eyesight in total darkness? It is interesting to note how in these caves natural selection has been enlarging and developing organs which are of use in darkness, even while in the same species *panmixia* has been reducing those which are useless. In the Mammoth Cave there is a blind, colorless, and wingless grasshopper. Eyesight, color, and wings have been aborted by *panmixia;* but it has singularly long and delicate antennæ, which serve as feelers, and which are not nearly so conspicuous in forms living in the light of day. It would seem then that natural selection maintains only what is of advantage to an animal, and when it neglects an organ, that organ tends to degenerate by the action of *panmixia;* and these laws apply to the physiological functions of organs, as well as to the structure of the organs themselves.

Is immortality essential to the Protozoon? Weismann claims that it is, for the whole body is the germ cell by which the race is perpetuated; hence, if the body should lose its immortality, the race would become extinct. Immortality then is retained by natural selection.

Now among the Metazoa the case is quite different. In these forms immortality is only essential to the germ cells. The body is merely the bearer and protector of these precious germs, and immortality is in no sense essential to it; hence it has not been maintained by natural selection, but has disappeared through *panmixia.*

Weismann suggests that the Metazoa, with their immortal germ and perishable body, have been evolved from the wholly immortal unicellular form something as follows: Many Protozoa form cluster-like colonies. In such groups those on the outer side must obtain food more readily than those in the center; hence the colony would become gradually differentiated into feeding cells on the outer side and reproductive cells on the inner side, the feeding cells supplying the reproductive cells with nutriment just as the digestive cells of Hydractinia supply the rest of the colony. The cells that are thus supplied with food would have no use for mouth, cilia, etc.; hence they would lose them, but might retain their reproductive powers. If these central cells retained their immortality, there would be no necessity for the feeding cells doing so also; and if natural selection does not compel the retention of a physiological character, it degenerates, just as a useless organ degenerates.

Certain of the lower forms, such as Volvox, suggest this manner of evolution of the Metazoa from the Protozoa. Volvox is a hollow sphere of cells, each of which is provided with a couple of long flagella, by means of which the colony swims. Some of these cells pass to the center of the sphere, and there undergo certain changes in form, becoming, in fact, the reproductive cells of the colony. When they are ripe, the rest of the colony withers up and dies. Hence we find in Volvox the first approach to a differentiation into germ and somatic cells.

Since Weismann made this startling assertion, that death is not an attribute of all living organisms, much opposing evidence has been brought forward. Most prominent and recent among his opponents is E. Maupas, of Algiers, who, after extensive study of some of the Infusoria, asserts that degeneration and death occur as normally among the Protozoa as among the Metazoa. Before entering on his experiments, Maupas first determined very carefully the habits of the different species which he chose for study. He found out the temperature to which they were best adapted, and the kind of food on which they throve best. Then he took a single individual and isolated it on a glass slide, on which it could be studied. This slide was kept over a dish of water, in a warm, damp chamber in which the air was so thoroughly saturated with moisture that evaporation was reduced to a minimum. During its confinement the animal was fed on its favorite food, and in every particular what seemed to be the most suitable conditions were maintained. He found that at the end of seven days there were no less than 935 Infusoria in his culture. One of these 935 he isolated and kept as he had the first. In four days this single one had increased to 230. One of these was isolated in the same way, and this process of isolating and confining one individual of each brood was continued through a large number of generations. He shows the rapidity of increase to be something almost incredible. Calculations show that in six and a half days a single Stylonichia might produce by fission a mass of protoplasm which should weigh one kilogramme, and that in thirty days the number of kilogrammes would be represented by 1 with forty-four zeros, or a mass of protoplasm a million times larger than the volume of the sun!

Cultures were made of no less than twenty different species of Infusoria, and were maintained during periods of time varying in different cases from two weeks to between four and five months. He found that aft r from fifty to one hundred generations had been prouuced by fission, there was clear evidence of a physiological decline, which seemed to indicate the approaching extinction of the culture. He withdrew some of the Infusoria from the culture and allowed them to mix with others of a different origin. With these they conjugated, and their full vigor seemed restored. If, on the other hand, they conjugated among themselves, observation showed that decline was so far advanced that the culture was doomed.

Soon the animals produced by fission were smaller—often being less than half the normal size. At the same time what might be called pathological changes began to appear. The cilia were absent on parts of the body, and the Infusoria seemed weaker and less able to digest food. In some species the micro-nucleus underwent changes, finally falling to pieces—a phenomenon which not unfrequently occurs in the cells of the Metazoa when the tissue is undergoing degeneration. Also the micro-nucleus was found to undergo marked pathological changes, finally breaking down and disappearing.

When this degeneration, which Maupas calls senile degeneration, reaches its maximum, nutrition becomes impossible, and death follows. Thus it would appear that the life of these animals is cyclic. During the period of reproduction, which is the adult life of the animal, a sort of physiological decline takes place, and this decline can be repaired only by conjugation.

Now if, during these experiments, the animals have not been injured or poisoned, it would seem at the first glance that Maupas had proved that among the Infusoria death may occur normally; and on the strength of his experiments he holds up Weismann's theory to ridicule. This is evidently unfair, for although he has shown that Weismann was wrong in ascribing immortality to the Infusoria, yet there are many well-known unicellular forms in which neither a physiological decline nor a process of rejuvenation has been observed. The Bacteria, the Cyanophyceæ, and yeast, increase by budding, spore building, and fission; conjugation does not occur, and unless their life history is much less well known than bacteriologists and botanists think, these forms are potentially immortal. The Infusoria, on the other hand, are the highest and most differentiated of unicellular forms. They have organs of locomotion, mouth, pharynx, some sort of excretory apparatus, myophanes (muscle-like structures), trichocysts, etc.; while in the lowest organisms none of these organs are to be found. Further, the Infusoria have a macro-nucleus which Maupas shows is vegetative in its function, and a micro-nucleus which is generative. If the macro-nucleus is lost, nutrition fails; and if the micro-nucleus is lost, conjugation is impossible. In many of the lower Protozoa no such differentiation has been observed, and there is merely one nucleus, which is surrounded by a mass of protoplasm.

In a recent article Butschli maintains that in the Bacteria the whole body is the nucleus, and that the surrounding mass of protoplasm, such as characterizes the Rhizopods, is absent. Between the Bacteria and Infusoria there is a wide gap in the zoological scale. Is it not possible that as the Infusoria were evolved from lower and simpler forms, the process of conjugation was first acquired? that when, in the cycle of metabolic changes, the protoplasm fell short of the point from which it started and to which it should return, this deficiency was made up by foreign substance obtained from an individual of different origin, and therefore of different material? Those of the primitive forms which retained their original immortality have left lineal descendants which we know to-day as Bacteria. Those which in a measure lost that power have either become extinct, or else acquired a habit of rejuvenescence by conjugation. In other words, those to which it was an advantage to retain their immortality have retained it, and those which varied in such a manner that immortality could be advantageously replaced by rejuvenescence have, by the action of natural selection, undergone this modification. If this is so, Weismann's error is not in claiming that death was an adaptation, but in asserting that all unicellular forms are immortal.

Weismann, however, is not ready to admit this. He claims that conjugation is a necessary condition of the animal's life, just as fertilization is a necessary condition for the survival of an ovum, and if conjugation is denied, the death in consequence is accidental and not natural; further, that the fact that conjugation is necessary does not imply that the protoplasm is not potentially immortal. He seems, however, to overlook the fact that a certain physiological decline has taken place, and that if there is any physiological decline the cycle of life is incomplete—therefore the seeds of death must exist inherent within the life of the animal. It is, then, for the present, impossible to speak of the Infusoria as potentially immortal, and to claim that that portion of the Metazoa which undergoes physiological decline has no equivalent in these forms.

Still another and earlier opponent of Weismann has urged serious objections to this theory of the origin of death. Professor Charles S. Minot was the first to maintain—and many have taken up his suggestion—that Weismann is fundamentally wrong in comparing the life history of a Metazoon, which is a complex colony of cells, with that of a Protozoon, which is a single cell. Minot urges that an individual Metazoon is comparable to a colony of Protozoa, not to a single cell. If this be so, then the death of a Metazoon (a colony of cells) has its only homologue in the degeneration and death of a culture of Protozoa. The Metazoon colony is the product of a single germ cell, as is also the whole culture of Infusoria.

This comparison seems safe between the Metazoa and those forms of Protozoa which conjugate, and in which senile degeneration occurs. But how is it when we bring those which do not conjugate under consideration? If this view be correct, then a single Metazoon is equivalent to all of a species of Bacterium which may arise through generations of fission. As far as our knowledge goes, these Bacteria are immortal, and their numbers almost infinite. We know, on the other hand, that nothing but the germ cell of the Metazoa possesses this immortality and vast power of reproduction.

But to return to Weismann's views. If death is not something which is inherent in living matter, but which is acquired, how is it that the length of life differs so markedly in different species? Weismann answers that the age which an animal may attain has been determined by natural selection, and also that the power of reproduction and length of life are correlated. In order to understand this view it is necessary to compare the length of life with the reproductive powers of different animals. Birds, as a rule, live to a surprisingly great age. Even the smallest singing birds live for ten years; while some live for twelve, or even eighteen years. A partridge lives from twenty to twenty-five years. A pair of eider ducks was observed nesting in

the same place for twenty years, and it is believed that these birds often reach the age of a hundred. The same cuckoo was recognized by its peculiar note in the same forest for thirty-two consecutive years. Birds of prey become much older, for they outlive more than one generation of men. A white-headed vulture was kept in a zoological garden in Germany for one hundred and eighteen years; and many examples of eagles and falcons reaching an age of over one hundred years have been recorded. Humboldt mentions a parrot from the Orinoco, of which the Indians told that none could understand it, for it spoke the language of an extinct race.

Now let us compare the length of life and reproductive powers of the partridge and an eagle, and see if there is any reason why one should live longer than the other. The partridge lives a little more than twenty years, and each year lays about twenty eggs. Hence a pair of partridges may produce about four hundred eggs in their lifetime. This is at the rate of two thousand in a hundred years. Yet, since the number of partridges in the forest does not increase, three hundred and ninety-eight of these eggs, or young, must be destroyed in twenty years; while but two survive to take the place of their parents. The eggs and young are destroyed by beasts and birds of prey. If these enemies increased very much in number, the partridge would become extinct, unless it laid more eggs.

It would appear, then, that the partridge lays just eggs enough to insure the continuance of its race; and, this being accomplished, death removes it. Many species have doubtless become extinct through the insufficiency of their reproductive powers. The number of offspring which, under ordinary conditions, would have insured perpetuation has proved insufficient when their enemies increased or the environment became unfavorable. The supply must be equal to the demand.

Now for the eagle. The eagle is one of the most powerful of birds, and builds its nest on such inaccessible cliffs that eggs and young are comparatively safe from marauding animals. Many, however, are destroyed by late frosts and snows. To be on the safe side, let us fix the duration of life of the eagle as sixty years; and of this, ten years are spent in immaturity. Hence there are fifty years of its life during which it reproduces. If the eagle lays but two eggs a year, a pair of eagles would produce one hundred during their lifetime. In a hundred years two hundred eggs against the partridge's two thousand; therefore the partridge produces ten times as many young as the eagle, and it is safe to say that the partridge has ten times as many enemies. If the life of either were shortened, the race would die out unless the power of reproduction were increased, or the struggle for existence became less severe.

Many sea birds, such as the petrel, auk, and gannet, lay but one, or at the most two eggs a year. Any one who visits a locality where these birds breed must be struck with the enormous number of eggs or young which are destroyed. The eggs are often laid on the bare rock on projecting ledges of a cliff, so that the slightest movement will precipitate them to the beach below. Every disturbance among the breeding birds is marked by a small avalanche of eggs or young, so that the beach below is strewed with broken eggs and mangled remains. If these birds were not long-lived, they would soon become extinct. Now all of these birds live much longer than mammals of a far larger size. The lion lives thirty-five years, the sheep fifteen, the fox fourteen, the squirrel or mouse about six. Most of these animals are much more fertile than the birds, and the young are much less exposed to dangers. The bird's egg is exposed from the time it is laid, while the young mammal is protected during its development.

Only the very largest of the mammals, such as the whale, the elephant, and possibly the rhinoceros, live as long as these birds. The elephant may live for a hundred or perhaps a hundred and fifty years, and reaches maturity when about thirty. A pair produce but a single calf about every ten years; hence, during their lifetime, a pair of elephants contribute but ten or a dozen young to the race.

Wallace shows that we are living now in a zoologically impoverished world. Almost all of the largest and strongest forms have recently become extinct: in Europe, the great Irish elk, the saber-toothed tiger, cave lion, rhinoceros, hippopotamus, and elephant; in North America, equally large felines, horses, and tapirs larger than any now living, a llama as large as a camel, mastodons and elephants, besides a large number of huge megatherians; in South America, an even greater number of megatherians, huge armadillos, a mastodon, large horses and tapirs, large porcupines, two kinds of antelopes, numerous bears and felines, besides the saber-toothed tiger.

Remains of all these are found in the recent deposits, and these animals lived till shortly before the northern continents were incased with the ice of the glacial epoch. It is possible that a change of climate, due to the growing cold from the encroaching ice belt, affected the flora. This would, of course, affect the food supply, and so tend to lessen the reproductive powers, and shorten the lives of the individuals. Lessened reproductive power and shortened lives of the individuals would surely result in the extinction of the race, and in this way the destruction of these forms may be accounted for. The starvation of the individual is therefore synonymous with the starvation of the race.

The above considerations seem to warrant the theory advanced by Weismann: *first*, that unicellular organisms may be potentially immortal; *second*, that death is an adaptation; and, *third*, that the length of life and the reproductive powers of animals are correlated.—*Technology Quarterly.*

FERTILIZERS FOR TOMATOES.

I have become satisfied that the difficulty with tomatoes in this latitude, where they are, as a rule, very unsatisfactory in midsummer, is very largely due to the general impression that heavy manuring is not good for them, especially the heavy use of stable manure. A large part of the benefit of well-rotted stable manure in a hot climate comes from the abundant carbonaceous matter mixed with it, which tends to keep the soil from baking hard in the summer heat, and preserves moisture. I have been particularly struck with the success of an old negro, a porter in a mercantile house in Raleigh, in growing tomatoes and keeping them up all through the summer. So I sought him out and asked about his method of cultivation.

"Well, boss," said he, "I'se jess got a bit of a gyarden to 'muse myself moonlight nights. I keeps a pig and some chickens, and saves their manure, and my boy scrapes up the hoss droppin's on the road, and we gits rich dirt and mixes it all up in a compose pile ready for spring. Den, in April, when I sets out my termatter plants I digs a big hole for every one of 'em and fills it mos' full ob dat compose. De holes is ober a foot deep. On de top I puts some of de sile, and sets de plant right in de middle, wid a stout stake alongside ob it, and ties de vine up to it; and it jess grows and grows, and keeps a-growin', an' I cuts off de side shoots as soon as I see de blossom on 'em. Dat's all, boss. Dem plants jess keep a-growin', and I cuts out de old straggly stuff now an' then, and has fresh shoots an' termatters all de time."

There is a lecture on tomato culture! Such heavy manuring may not do everywhere, but in this climate of alternate deluges and droughts the old colored man's plan works well, and will be tried in my own work next season. I am not sure, however, that it is advisable here to train the plants off the ground. Close training to one main stem exposes this stem too much to the sun and makes it short-lived. I am inclined to believe that better success will be had here from vines sprawling on the ground, and shading with their foliage not only the stem of the plant but the ground as well. I have abandoned varietal tests of tomatoes, and will, hereafter, study modes of culture and development.—*W. F. Massey, in Garden and Forest.*

THE GREAT SALT DESERT OF PERSIA.*

The mountains of Siah Kuh rise to a height of about 5,000 feet above the level of the surrounding plains, which themselves constitute a plateau of about 3,000 feet to 4,000 feet above the sea level. Looking toward the north, I could distinctly trace the course of the masonry causeway built by Shah Abbas to facilitate the communication with the south across this part of the desert, but the most remarkable feature of the landscape was that presented by the Darya-i-Namak, the extent of which was fairly well distinguishable from this point of vantage, in spite of the glare which surrounded it.

For miles and miles away at our feet stretched what looked in the distance a vast frozen lake, but which was in fact a deposit of salt that entirely covered the low plains toward the south, and extended as far as the eye could reach toward the east and west, glittering in the sun like a sheet of glass. Toward the extreme west we imagined that this solid sheet was replaced by water, for we fancied we could see the ripples on its surface and the foam along the edge as the wind, which was high, drove it against the shore; but this may only have been owing to the heated air upon the surface, and the broken pieces of salt which were strewn along the margin. We sat for hours looking at this strange spectacle and examining it through our field glasses, while our guides, who were some of the wild Ilyats, or wandering tribes which haunt this neighborhood, entertained us with all manner of strange stories regarding the peculiarities of its composition and the dangers to be encountered in traversing this vast deposit of salt.

According to their accounts, it was of the consistency of ice, and, like the latter, formed a coat of varying degrees of thickness upon the top of the water or swampy ground which lay underneath it. In some places they declared that this layer of salt attained a thickness of several feet, and that with such a degree of density that laden camels and mules could cross over it with perfect safety; while in other places where this was not the case, the crust of coagulated salt would break under their weight did they attempt it, and they would be engulfed in the waters or morass below beyond all hope of extrication. There appeared to be but one path across, which only those who were in the habit of traversing it, such as the owners of camels and mules, were well acquainted with, and which no one else in consequence attempted without a competent guide, for there was but little to mark its course, and if once lost sight of, the unfortunate traveler might wander for hours or days without finding it again, and probably end by dying of thirst if he succeeded in avoiding the more dangerous parts incapable of bearing his weight, where he would inevitably be swallowed up. They told us that the passage across this plain was quite impossible by day, at any rate if the sunshine were very bright, on account of the dazzling effect which its reflection upon the white surface of the salt produced, which was such as to quite prevent persons attempting it from seeing where they were going; and they recounted numerous instances of cases which had occurred of travelers who had disappeared from losing their way, and never been heard of again. Of course it seemed to us impossible to imagine how all this could be the case, for in a saturated solution of salt and water the salt would naturally be deposited upon the bottom, and not caked upon the surface; the guides, however, were so positive about the truth of what they said, and the appearance of the plain before our eyes seemed so peculiar, that our curiosity was thoroughly aroused, and we determined in consequence to completely change our intended route for the purpose of crossing the salt, especially as the moon, being just at its full, every facility was offered for doing so. Our muleteers we found to make no objection, as they said that they were in the habit of crossing by this route, and that the surface of the salt was so hard and smooth that it presented capital footing for the baggage animals. The following evening, accordingly, we found ourselves with our whole convoy of eight camels, sixteen mules, and three horses, approaching the margin of this salt plain, which was distant about fifteen miles from the foot of the mountain. As we neared this margin, the ground, which had been hitherto hard and dry, became damp and sloppy, so that we had to confine ourselves to moving along a distinct track, which had probably been used for centuries. To judge from the appearance of the ground here, a regular swamp must extend from the salt for some distance along its margin at certain seasons of the year, for on all sides were to be seen marks of animals who had strayed off the track, and got stuck in the clayey mud, from which it would seem in many cases, from the skeletons lying about, that they had been unable to extricate themselves.

After following this track, as it wound through this swampy ground for about a mile or so, we entered upon the sheet of salt itself, which, where the incrustation was thin, as was the case for some distance from its edge, was soft and sloppy, and mixed with earth resembling very much in its appearance the edge of the ice upon a frozen pool when a thaw has set in. As we proceeded, it gained more and more in consistency, till, at a distance of three or four miles from the edge, it looked like nothing more than a surface of very solid ice, such as might have been seen on any pond in England during the course of last winter. For this indeed, so far as its appearance went, it might easily have been mistaken, had it not been that, though the whole area over which it extended was perfectly level, the surface itself was not quite even, but resembled more that of ice which had partially thawed and then frozen again after a slight fall of snow; and, further, that instead of being continuous, it was broken up into countless polygonal blocks, whose dimensions varied from about six inches across to two or three feet or more. Of the solidity of this incrustation there could be no doubt, for there we were, camels, horses, and mules, traveling over it without a vibration of any kind being perceptible, or any sign of our weight making an impression on it. After marching for about eight or ten miles upon this strange surface, we halted to examine, as far as we could by the moonlight, its composition. We tried, by means of a hammer and an iron tent peg, to break off a block of salt to take away with us as a specimen, but found it far too hard for us to make an impression upon, and though we succeeded in bending our tent pegs almost double, we did not accomplish our wish; we managed, however, to chip off a lot of fragments, which we found here to be of the purest white; these were quite hard when we got them, but after keeping them a day or two they took up so much moisture from the air that they got soft and friable and changed their color to a slaty hue.

We were assured by the muleteers and others that at this distance from the edge the salt deposit was as thick as eight or ten feet, and it seemed possible from our failure in the attempt to bore into it that this might not be any great exaggeration on their part; they stated also, as I have mentioned, that under this crust lay, if not standing water, at any rate a quagmire, and that if we had succeeded in our intention of breaking through the salt, the water from beneath would have burst through the opening thus made and flooded all the surrounding space; they further told us that in the winter, when the snow fell and melted on this surface, there was always water standing upon it, and that later on, as the snows on the surrounding higher ground thawed at the approach of spring, this increased to a depth of two or three feet; but that the mules could always cross so long as it did not get too deep for them to find footing, for that the layer of salt itself never lost any of its solidity, in spite of the water lying on it.

It is difficult to explain this phenomenon except upon the theory that this incrustation is the deposit accumulated upon these low plains in the course of centuries upon centuries, during which the annual melting of the snows upon the mountains and highlands, besides the rainfall and the perennial streams which drain into this basin, have brought down in the water from the strata of salt through which they pass these tremendous quantities of salt in solution. The summer sun has dried up the water by evaporation and left the salt deposit lying upon a soil more or less saturated with moisture, this layer of salt thus deposited has gained in thickness and consistency year by year until it has become a solid homogeneous mass too firmly bound together in the parts distant from the edge, where its thickness was most (owing to the greater depth of water which accumulated there, and consequent larger amount of salt deposited), to be broken by any pressure of water from below. The perennial streams have thus poured their waters underneath these strata, as the accumulation of water would naturally commence at the lowest part of the hollow, which would be about the middle of the salt plain, while the floods of water brought down by the rain and melting snow would overflow on to its surface from the margins. This is the only way by which it occurred to us that we could account for the dead level of the crust, which, though covering a space of ground more or less hollow in its nature, as was evident from the run of the water all around, did not appear to us to slope in any direction, and also for the fact that on piercing through this crust water spouted out from below. Though we had no ocular demonstration of this fact, we were satisfied that it was the case from the accounts of a party of our servants whom we sent out the following day, when we had reached the further edge, to bring us a block of salt at a distance of a mile or two from the shore; another fact in support of this theory was that nearer the edge, where the crust was thinner and thus unable to resist the pressure from below, it had evidently been burst by the rising of the water during the winter and spring, and lay tossed about in fragments.

After this halt we continued our march and arrived at the farther margin about 3 A. M.; it had thus taken us a good eight hours to cross this plain of salt, so that the distance traversed could not have been less than about twenty miles. As we expected, we found that, as we approached the farther side, the crust of salt got thinner and thinner, till, on one occasion, getting slightly off the track, we quickly found the horses and mules sink through it almost up to the girths in a substance that resembled exactly melting snow, out of which we had to make the best of our way toward the harder material upon which we had been marching for so many hours. At length we hit off the beaten track which had been hardened by constant use during so many centuries, and were thankful indeed when we found ourselves again at last on *terra firma.*

* From a paper, by C. E. Biddulph, in Proceedings of the Royal Geographical Society, November, 1891.

EARLY HISTORY OF THE PORTE ELECTRIC SYSTEM.

THIS is an electrical transportation system, making use of stationary solenoids, through which an iron carrier is drawn by successively passing an electric current through the solenoids. It appears that the general construction and the principle involved in this electrical transportation system was suggested many years ago by the Chevalier Bonelli and Prof. Minotto, both of Turin, Italy.

An English patent obtained by Bonelli on January 8, 1862, No. 58, is for an "apparatus for transmitting dispatches and small articles by the agency of electricity." In the specification of this patent it is stated that the "essential feature of novelty is the adaptation of the tractive power of induced electric coils to cause an armature of iron constructed in the form of a hollow vessel or casing made to contain articles of various kinds to pass along or through lengths of tube surrounded by such electric coils."

A French patent granted to Bonelli on December 18, 1861, No. 52,301, is for practically the same system as that shown in the English patent. The drawing, however, is somewhat different, since it shows a continuous tube surrounded at intervals by the wire coils. In both the patents above referred to, a battery is shown on the traveling carrier for energizing the coils; but the suggestion is also made that a stationary battery could be used.

An Italian patent granted to Giovanni Minotto on December 31, 1861, is for what is termed an "electrical post, or a new method of transporting letters, packages and persons by means of electricity."

In this patent are found a series of hollow helices of insulated wire, each of which encircles the track, and a wheeled carrier moving them. One of the terminals of each coil is connected with a line wire leading from one pole of a stationary battery, the other pole of which is connected with the ground. The iron carrier is provided with a contact device on its top, which serves to close the circuit through the particular coil in which the carrier has entered the rails and ground serving as the return conductor. It is stated that the entire system may be arranged on the ground or supported on posts; also that when passengers are to be transported, openings for ventilation and light are provided, together with brakes for arresting the motion of the carrier or train of carriers. It is also mentioned that on inclines a greater number of coils are used, and that the battery power is increased; furthermore it is stated that the carrier can itself be converted into an electro-magnet by surrounding it with a wire coil through which a battery current is constantly passed.—*Mr. A. M. Tanner, in the Electrical World.*

ELECTRIC DECOMPOSITION OF CHROME ORE.

By E. F. SMITH.

Two years ago the author mentioned that an intimate mixture of chrome iron ore and melted potassa is decomposed by the introduction of the electric current, and that the chromium oxide present is converted into soluble potassium chromate. The earliest attempts were made with a current of one ampere. The oxidation of the mineral was apparently completed in fifteen minutes, but the wish to economize time by increasing the current led the author astray, and many decompositions, fruitless as well as successful, were made before the most satisfactory conditions were ascertained. It was found that a more powerful current acted chiefly upon the oxides of iron contained in the ore and the potassa employed, liberating larger or smaller portions of the respective metals. The occurrence just mentioned seems to take place after a partial decomposition of the mineral, so that a little of the chrome ore always remains undecomposed.

The following method was found after many experiments to give good results:

Method of Oxidation.—Thirty to forty grammes caustic potassa are brought to fusion in a nickel crucible 1⅝ inches in height and 2 inches in width, and gently heated until the excess of water is evaporated. The crucible is then set upon a heavy ring of copper wire in connection with the anode of a battery.

During the decomposition the crucible is gently and uninterruptedly heated by means of a small flame. The mineral is weighed out upon a watch glass and is then carefully placed upon the liquid potassa by means of a camel's hair pencil. The crucible is covered with a perforated watch glass, and the platinum rod connected with the cathode of the battery is let down into the melted mass, thus producing the current. Portions of the melted mass are projected against the under side of the watch glass, but the liquid soon collects in drops and falls back into the crucible, and thus restores any traces of ore which have been projected upward by the bursting of the gas bubbles.

Experience shows that it is preferable to use the crucible itself as an anode. Before the current is finally interrupted it must be reversed by means of a commutator, which is left permanently in the current along with a Kohlrausch ampere-meter. This is necessary because metal is deposited upon the cathode and contains particles of ore which are thus withdrawn from the oxidizing process. By reversing the current these particles of ore are set at liberty and made capable of oxidation.

The quantity of ore to be taken for analysis varies from 0·1 to 0·5 gramme. The ore used for oxidation must be ground quite fine. In the author's experiments the ore was never used in such a fine state of comminution as is prescribed in order to obtain a complete decomposition by other methods.

For the quantity above indicated the current must not exceed 1 ampere. As for the time needed for oxidation, the quarter of the ore is indubitably decomposed in 15 minutes, but to effect a complete decomposition of the ore a time of 30 to 40 minutes is recommended. Much depends on the resisting power of the sample. In this respect chrome ores vary exceedingly—a difficulty which has to be overcome in every method for their analysis. Half an hour at least should be allowed for completing an oxidation by this method.

As the decomposition proceeds, the melted potassa takes a deeper yellow; the part which climbs up on the edge of the crucible and the watch glass resembles a cauliflower.

The current may now be interrupted. When this has taken place the platinum rod (the cathode) is lifted out of the liquid, the watch glass is carefully lifted off the crucible with nickel forceps, its lower surface is rinsed with water, and the washings are collected in a beaker. The crucible is then removed from the copper ring and set upon a marble plate to cool. The platinum cathode must also be washed with water. It appears black in consequence of the deposit of metallic iron which has been formed upon it.

It is judicious to dissolve this coating in dilute hydrochloric acid in order to be satisfied that no undecomposed ore is present in it.

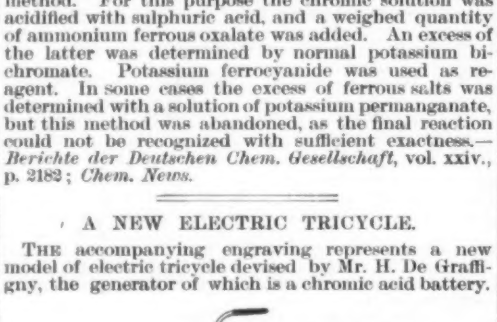
When the crucible is cold it is placed in a beaker holding about 300 c. c., covered with water, and set to digest upon a warm plate. In a few minutes the contents of the crucible are entirely dissolved and the crucible itself may then be removed from the liquid. It contains, besides an excess of potassa, potassium aluminates, silicates, manganates, and chromates. The insoluble matter in suspension consists chiefly of iron oxide.

After the alkaline solution has been heated for a time on the plate, the insoluble part is filtered off and *thoroughly* washed in boiling water. The vessel containing the soluble salts is set aside, and the portion insoluble in water is treated with hot hydrochloric acid. It must dissolve completely without leaving a residue. If this is not the case, the decomposition is incomplete.

Determination of the Chromium.—The chromium in the yellow alkaline filtrate may be determined either gravimetrically or volumetrically. In his more recent determinations the author used exclusively the latter method. For this purpose the chromic solution was acidified with sulphuric acid, and a weighed quantity of ammonium ferrous oxalate was added. An excess of the latter was determined by normal potassium bichromate. Potassium ferrocyanide was used as reagent. In some cases the excess of ferrous salts was determined with a solution of potassium permanganate, but this method was abandoned, as the final reaction could not be recognized with sufficient exactness.—*Berichte der Deutschen Chem. Gesellschaft*, vol. xxiv., p. 2182; *Chem. News.*

A NEW ELECTRIC TRICYCLE.

THE accompanying engraving represents a new model of electric tricycle devised by Mr. H. De Graffigny, the generator of which is a chromic acid battery.



ELECTRIC TRICYCLE.

The vehicle has the form of an ordinary tricycle, but the saddle is replaced by a light wood box, which contains the mechanism and serves as a seat to the cyclists. The steering wheel in front is maneuvered through a rod provided with a handle, the brake is maneuvered by the foot, and the lever of the commutator is within reach of the hand.

The generator consists of two batteries of 18 elements grouped in tension and connected in quantity. Its weight filled with liquid does not exceed 44 lb. It actuates a small dynamo whose motion is transmitted to the axle of the driving wheels through two trains of gear wheels and an endless chain. The complete vehicle in running order does not weigh more than 155 lb., and the parts submitted to friction are mounted upon steel balls.

In the different trials made at the works of Mr. Lenain, at Albert, and upon the highways of the department of Somme, two months ago, it was found that the machine was capable of developing ½ h. p. at the beginning, and ⅜ h. p. at the end of four hours' operation. Carrying two persons of ordinary weight, the vehicle made, on an average, from 10 to 12 miles per hour—a very satisfactory speed.

As for the net cost of the energy produced by the batteries, it is pretty high, being about two cents per mile traveled, thus putting the electric horse hour at fifty cents. But it is certain that such cost would be immediately decreased, while at the same time the speed would be increased, were these electric vehicles to come into extensive use.—*Le Genie Civil.*

RATE OF PROPAGATION OF INDUCED MAGNETISM IN IRON.

THE question, considered in a simple form, may be put thus: Suppose a magnet were suddenly brought up to one end of a long iron rod, what length of time intervenes between the occurrence of magnetization at the near end and at the far end?

Every one, probably, would at first be inclined to say that the speed along the bar would undoubtedly be about the same as the velocity of light, and this supposition would naturally follow if the energy to places along the bar be supposed transmitted through the surrounding space; but, on the other hand, the speed may be much less if the energy of magnetization is transmitted from particle to particle in the iron—the orientation of the molecular magnets being, as it were, passed from each to the next along the bar. In such case we would, of course, expect the velocity of propagation to be comparable in speed with that of molecular phenomena rather than that of disturbances in the ether.

The velocity of sound, with which we may, perhaps, compare it, is in iron about 16,000 ft. per second. The transmission of sound resulting from vibratory movement can be said to depend on the mass of the molecule, and on the mutual forces keeping the molecules in position; while the rate of propagation of a magnetic disturbance of the kind supposed would depend on the moment of inertia of the particles (assumed to be molecular magnets) round their axes of rotation, and on their mutual magnetic moments.

The propagation of such a disturbance can be observed in Prof. Ewing's magnetic model. The model, which consists essentially of a great number of small compass needles placed within each other's action, but not near enough to touch, can be disturbed at one place by bringing a magnet near, or otherwise. The disturbance then is seen to spread throughout the model, much in the same manner as we have suggested a magnetizing disturbance to be propagated in iron.

The method proposed to test matters depended upon the principle of the interference of waves traveling in opposite directions observed through the production of stationary waves.

Thus, if a bar of soft iron have two coils of wire placed one at each end, and if the same alternating current be passed through both coils, disturbance of opposite signs traveling in opposite directions along the bar should interfere, provided the rate of alternation and the length of the bar are chosen suitable to the rate of propagation.

It was proposed to detect the nodes or places of interference by means of a telephone in circuit with a third coil which could be slid along the bar.

Instead of employing two alternating coils, the bar can be bent round to form a ring, and one coil will be then sufficient.

Some preliminary experiments with a straight bar having given faint indications of the existence of places of minimum intensity, closed magnetic circuits or rings, formed of a great number of turns of soft iron wire,* were then tried with more decided results. When the alternating coil was in certain positions on the ring the telephone coil could be placed at points where no sound, or if any very slight, could be heard—the sound reaching a maximum in places somewhere between these points. These nodes and internodes occupied about half the ring—the opposite half of the ring from that in which the alternating coil lay. On approaching nearer the alternating coil, apparently the very unequal length of the paths prevented any effect being observed.

It was without difficulty ascertained that these were not the nodes looked for, because the distance between them remained unaffected on changing the rate of alternation. The distances from node to node also were found to measure different amounts (though on the whole there was a decided tendency toward regularity). The average distance apart of the nodes in the different rings tried lay between 10 and 18 inches.

The occurrence of the nodes might have been very well attributed to the ring being locally irregular in its susceptibility to induction, but for the irreconcilable fact that the effects on either side of a node were found to be of opposite phase, just as it would be were the phenomenon due to stationary interference waves.

This was ascertained by means of two coils connected in the same sense in series with the telephone. When these coils were arranged at places of equal intensity, one on each side of a node, no sound was to be heard in the telephone, the effects neutralizing one another. A commutator, to throw in the coils singly or together as desired, is convenient for making this experiment.

From this, one would naturally assume that the currents induced on either side of a node must be of opposite sign, seeing that they neutralize each other in the telephone; but experiments with the galvanometer show it not to be the case. To test this, the galvanometer is connected up through a commutator arrangement fixed to the originator of the primary current in such a way as only to admit of the currents induced in one direction passing. Tried in this way, no difference in the direction of the current on either side of a telephone node was found, or, indeed, any trace of a minimum effect at these points. The thing can also be tested by means of a ballistic galvanometer, and a reversing key with battery, for, with a reversing key and telephone, the nodes, which are quite independent of the speed, are to be found, as well as the opposite phase effect. The ballastic galvanometer gives no indication of there being any difference at the nodes from elsewhere, and the deflection everywhere is in the same direction.

It was thought that perhaps the telephone effect was in some way connected with the fact that the form of the alternating current was not a simple wave or sign curve, owing to the method employed in producing it. This consisted of a rotating commutator, which threw in circuit alternately two cells connected up singly and in opposite directions. For this reason, the effect, when using a small alternating machine with about 40 alternations per second, was compared, and was found to be in no way different. Also what must have been a very regular variable current of the simple harmonic type was procured by means of a microphone and an organ pipe. This gave like results.

One is thus left apparently to suppose the sound in the telephone to be due to a peculiarity in the character of the curve representing the rise and fall of the current, probably something of the nature of a subsidiary oscillation; this subsidiary oscillation being absent at the nodes, and of opposite sign on either side.

As mentioned before, it is necessary for the alternating coil to be placed at definite positions, in order that the system of nodes and internodes should occur. These positions of the alternating coil are at about the same average distance apart, and are of very much the same character with respect to regularity as the nodes of the telephone coil. In fact, if the alternating coil and the telephone coil change places round the ring, the best position for the alternating coil will always be between two nodes, and the nodes will be found

* Two rings were made of No. 21 soft iron wire, one about 10 feet and the other 14·5 feet in circumference. Both had 8 pounds of wire wound on. The wire used in a third ring was No. 23. This ring was about 12 feet in circumference. There was about 4 miles of wire put on. The wire of this and the 14 feet ring was well coated with shellac before winding, so as to minimize Foucault currents.

situated between two old positions of the alternating coil. If the alternating coil be placed at a point where a node was found in some other position of the alternating coil, the system of nodes and internodes generally completely disappears, and now on moving the telephone coil round the ring the intensity uniformly diminishes until the diameter is reached, and then increases round the other half of the ring. This gives the phenomenon a distinctly resonant character. The induced current as observed by a galvanometer is always of the latter character—that is to say, a uniform fall, and then a rise on going round the ring.

As a rule the permanent magnetism of these large rings is irregular, and apparently apt to change frequently. A determination of the permanent magnetism was easily made by means of one of the coils connected with a ballistic galvanometer. By moving this through a given amount at a time, say an inch, and noting the throw of the needle, one was able to plot out a representation of the state of the permanent magnetism. In this way, places where no throw occurs were found, while to either side of such a point the throw changed sign. It was sometimes found that there was a decided tendency for the position of no throw to occur between two telephone nodes, the throw changing sign on either side of these points. But further experiments showed that this arrangement of the permanent magnetism was probably accidental, and due to the very currents employed in making the telephone observations. For when only very feeble currents had been used on a ring, these consequent poles were absent.

It is possible, as one would expect, to artificially make a minimum intensity position, at any point on a ring, by winding on a few turns of thick copper wire. But the fact that the phases on either side of such a point (found as before by means of two coils in circuit with a telephone) are the same precludes the idea that the nodes can be due to Foucault currents.

Obviously, however, the phenomenon depends on some permanent peculiarity round the ring which happens to occur fairly regularly. What this peculiarity is, or how it is brought about, I have not yet been able to discover.—*Fred. T. Trouton, in Nature.*

HOW TO INVENT THE SUCCESSFUL COMPETING TELEPHONE.

By EDWARD P. THOMPSON.

A POINT of valuable knowledge, among other matters, with which the would-be inventor of the successful competing telephone should be equipped is the gist of each class of telephone which has been invented thus far. It is almost safe to say that the successful competing transmitter will consist of some slight improvement over some existing improvement or original invention. The most powerful example which presents itself is the very transmitter which suggests the present problem. Although the result is far inferior, the Reis transmitter of musical sounds is exactly like the Berliner transmitter, except to those who know the gist of both. In each case two terminals of an electric circuit are normally in contact. However, when the device is in operation, the contacts separate in the one, and remain together in the other with variable pressure. It is found that all the telephones at present known are divisible into a comparatively few classes, and that a short sentence will give the pith of each. They are treated, not in any chronological order, but in the order in which they naturally appear in the mind. Even if read, not for the purpose of assisting in inventing, the classified knowledge may be useful in other ways.

The State of the Art.—In one or more transmitters at present known, electrical undulations, corresponding to air vibrations, are produced by causing the mechanical energy of the condensations and rarefactions of the air.

To vibrate a diaphragm of iron before the poles of a magnet.

To vibrate the diaphragm of iron before the poles of a magnet in which the core is partly or wholly of steel.

To vibrate a steel diaphragm before the poles of a magnet with or without a core.

To vibrate a magnet before the poles of a second magnet.

To vibrate an iron sheet *between* the poles of a magnet.

To vary the temperature of a heated conductor of very small diameter, such as a platinum wire, the condensations and rarefactions of the air causing the alternate heating and cooling of the conductor (comparatively), whereby its resistance is similarly varied.

To vary the temperature upon the face of a thermopile, the condensations and rarefactions of the air causing an alternate heating and cooling of the thermopile, whereby electrical undulations are produced (theoretical).

To vary the length of a continual spark between the two electrodes, the electromotive force of the current being sufficient to maintain the spark (theoretical).

To vary the linear resistance of a ligature, such as a carbon filament, the air vibrations causing a conducting liquid to rise and fall alternately along a part of the length of the wire.

Same as above, the air vibrations causing a second conductor to intermittently touch or short-circuit variable portions of the first conductor.

To vary the amount of light falling upon a conductor, such as selenium, which is sensitive to light in such a manner that for variable light its resistance varies.

Same, except that a substance sensitive to heat rays is employed.

To vibrate a card board, supporting iron filings, before the poles of a magnet.

To circularly vibrate the armature of a minute dynamo before the poles of the field magnet.

To vary the pressure existing between the two carbon or metallic or conducting liquid electrodes normally and abnormally in contact with each other.

Same, the number of the electrodes of one or both polarities being increased.

Same, one of the electrodes, when metallic or carbon, being pulverized.

Same, in which one of the electrodes is a valve, loosely located upon the end of a tube which is the other electrode.

To vary the pressure upon the plates of a voltaic pile, an alternate increase and decrease of distance between the plates causing variable amounts of current generated.

To vary the shape of a globule of mercury balanced in a conducting liquid, the vibrations of the better conductor, mercury, varying the resistance of the circuit.

To vary the static charge of condenser plates, whereby the electric current of the line becomes varied as to its electromotive force.

Conditions of the Problem.—It is needless to mention that these are very severe. The transmitter must possess novelty over all those at present known, and further, it must be equal and if possible superior to the carbon transmitter. It should be applicable to long lines, and in such a manner that the receiver will give forth the words clearly and loud enough to be heard intelligently. It should serve the test of transmitting the ticks of a watch and whispering, when two or three feet away from itself, not simply over a small distance, but for a mile or so. For a short distance it should transmit the sound of heavy breathing. It is assumed that a good Bell receiver is used, such as that on which the patent expires in March, 1893. One of the difficulties, in order to be as profitable commercially as the carbon transmitter, is the cost of construction. The latter consists substantially of two pieces of compressed carbon powder, a diaphragm of tin-type metal, and the frame, the carbons being supported in a relatively yielding position, and means of adjustment being provided. It is one of the cheapest electrical devices manufacturable.—*Electrical Engineer.*

THE ELECTRIC STAIR CLIMBER.

ELECTRICITY in all its forms is entering further and further into the uses of centers of human population. Rapid telegraphy, telephony, and electrical machines, with their various applications to lighting, metallurgy and to the mechanical transmission of power in manufactories, have for the last fifteen years shown incessant progress.

In addition to the important applications of industrial order, there are others of a more modest character which respond none the less to our daily needs, and render a host of minor services, the necessity of which

ELECTRIC STAIR CLIMBER.

is appreciated better and better from day to day. In this category we must mention the interesting electric stair climbers which Mr. J. A. Amiot, the engineer, exhibited this year at the Exposition of Labor at the Palace of Industry, and which obtained a deserved success.

It is a question, in short, of a practical utilization of electric energy realized under remarkable conditions of simplicity and safety.

Every one to-day, be he landlord or tenant, is agreed as to the utility and sometimes even, in our large modern houses with interminable stories, as to the necessity of the elevator. Owing to it the upper apartments are pleasanter to live in than the others, since the air therein is purer and more salubrious, and the dust and noise from the street reach them with difficulty. But the necessities of the installation render the use of the elevator difficult and often impossible. The car that it necessitates is spacious, and the room that it requires is but rarely met with in houses constructed in times gone by; so it is, therefore, necessary to install it in the court yard, which carriages often thereafter can no longer enter. The rod of mechanical elevators is lengthy and necessitates the sinking of a very deep well, which the nature of the subsoil does not always permit of establishing without very great difficulty.

In addition to the cost of installation, which is generally high, it is necessary to count every year upon a large outlay for the running of the apparatus, and which is sometimes such that certain house owners, after paying the cost of establishing an elevator in their dwelling, have left it idle in order to avoid the expenses of operating it and keeping it in order.

Let us add that the hydraulic elevator, save in the case of certain important improvements introduced by special manufacturers, is dependent upon the distribution of the water in the house and upon the quarter in which the latter is situated. Some grave accidents have resulted from it, and it is not judging this ingenious apparatus unjustly to say that it is often regarded with justifiable distrust by the public. A person, even though he be a mechanic, hesitates to be inclosed in a car at the bottom of the house, and, the button pushed, to confide in the good organization of an apparatus inspected and verified from time to time. This is not pusillanimity, for it is certain that it would be impossible to jump out of the elevator that is carrying you, or to arrest it easily should some accident occur to its motive power. There are elevator accidents, just as there are railway accidents. They are relatively rare, but always grave.

Mr. Amiot has proposed to remedy the general inconveniences that we have just pointed out by having recourse to electricity as a motive power without having to take either stairs or the width of the car into consideration. The idea of utilizing electric energy for the operation of ordinary elevators instead of employing hydraulic power is not new. There was an elevator of this kind shown at the Exposition of Electricity of 1881, and since then some analogous types have been devised; but that is not the question here, and the inventor has not proposed to adapt electric energy to the operation of a familiar apparatus. That would have been to meet again with the majority of the inconveniences that we have mentioned. It is the arrangement itself that he has attacked, and this is how: The electric stair climber consists, essentially, of a car rolling upon two superposed rails and carrying a box, and of an electric windlass which actuates the car through a steel cable guided by rollers.

This brief description, which the accompanying engraving will make better understood, shows the simplicity of the arrangement adopted.

The security is complete, owing to the enveloping form of the box, which dispels all apprehension by always presenting to the person who is rising or descending an invariable point of support. Moreover, an eccentric brake stops the apparatus at the top of a step—that is to say, at a height of about nine inches—in case the cable (which is calculated to resist a traction of 13,000 pounds) chances to break. Experiments made at the Exposition of Labor in simulating an accident of this kind constantly succeeded.

The stair climber has the advantage of occupying, in width, only about twelve inches of the steps of the staircase, a little less than is taken up by a person going up or down—that is to say, in the part necessarily unused for travel. It is, as may be seen, adaptable to all existing staircases without requiring any essential modification or any masonry work. The two rails are simply fixed by bolts to the banisters, which are consolidated thereby.

As for the electric current brought into play, that is feeble, and the conductors that convey it being out of reach of the hand, no shock is possible. The current is obtained by simply connecting the motive apparatus with the street distributing wires. In the exceptional cases in which there is no such line of wires, a gas, petroleum or compressed air motor, or batteries or accumulators, may be installed. The electric installation lends itself naturally to the lighting of every house and staircase independently of the hoisting of visitors.

Let us add that the maneuvering of the electric stair climber is of extreme simplicity. The person who makes use of the apparatus operates it himself, through the shifting of a lever, which he has under his hand, and around which are marked the words, "Up," "Stop," "Down." Buttons upstairs and down permit of calling the apparatus at any point of the staircase where it chances to be, and a peculiar safety device prevents any false maneuvering. Finally, the apparatus stops automatically at the end of its travel, so that no forgetfulness or negligence on the part of the person who is using it is to be feared.

Upon the whole, Mr. Amiot appears to us to have obtained in the stair climber that he has constructed a practical apparatus, which is utilizable on any staircase whatever without much expense and which causes no disturbance in the use of the stairway itself, for it makes no noise and occupies an extremely small space. It affords valuable advantages to the tenants as regards the facility of occupying top stories, and also to the landlord, who will be able to let such apartments more easily.

This apparatus deserves to be classed in the highest rank among the applications of electricity to the house that we alluded to in the beginning of this article, and which are daily continuing to develop in a series of uninterrupted progress.—*Le Genie Civil.*

NEW YORK AS IT MAY BE IN THE YEAR 2000.

PARODIES and imitations of Mr. Bellamy's dream of the good time coming have been numerous; and yet the public doesn't seem to tire of them. Our forbears, not so long ago, in the ages of faith, spent much of their time in looking back at the past. In both cases the Golden Age is the object of vision, but its location has been changed. To-day it is dimly seen through the mist of the future; in the good old days, which, alas! were not so good, it was buried in the mystery of the past.

Well, then, dreams of this misty Golden Age being so pleasant, may we not in the opening weeks of the new year indulge in one about the city of New York in say the year 2000 A. D.? We may, and we will. But how shall we transport ourselves to that period? Some of the Bellamyiteists—pardon the barbarous but descriptive word—manage it by getting the hero knocked on the head by something. When he recovers consciousness he finds himself in an earthly paradise not yet due for several hundred years, or else on one of the planets, whose inhabitants have been vastly more progressive than the stupid Tellurians. But when we recall the fact that Mark Twain's Connecticut Yankee was sent back to the time of King Arthur through a blow on the head, we hesitate. We don't want to risk fetching up in the days of some of those old dead and gone bad men, who would just as soon as not clap us into a donjon keep for an indefinite period, or even put us to death. It is altogether more pleasant to meet them in our histories.

What spell shall we use to project ourselves forward to the year 2000? Tutelary genius of Gotham, shade of old Father Knickerbocker, and spirit of Modern Progress, be with us! Presto! the present grows dim, the dear, old, dirty, and shabby New York we know so well through every one of our five senses fades away, and Manhattan, the proud and happy Metropolis of the World, stands before us.

The city we see is not so much a city as a blending of city and country. The people have learned what their forefathers did not know, that bricks and mortar, or even people, do not make a metropolis. There are no longer any of those human hives called tenements—

they disappeared long ago. Every other block is left vacant, and is beautifully kept as a park or garden. Of course the city is vastly larger than the old city of New York. It includes the whole of Long Island, Staten Island, and Westchester County, both banks of the Hudson River for fifty miles, and a good portion of the States of Connecticut and New Jersey. We smile as we read of the old-time talk about consolidating with Brooklyn; the former bed room of New York is now one of the central wards of Manhattan. And the present heated discussion is about the propriety of consolidating Manhattan and Philadelphia.

As already mentioned, every dwelling in the city stands by itself, with windows on every side. That one fact has added incalculably to the happiness and health of the city. We shudder as we read of the barbarous "brown-stone fronts" of old New York, with their rows of square holes called windows in front and behind, and the unwholesome darkness and stuffiness of their rooms. And when we read of the old New York "flat," we hesitate to believe that such an outrage on humanity was ever perpetrated. But then we reflect that everything was possible in the dark ages.

Speaking of the size of Manhattan suggests the pavements and the means of locomotion. The pavements are made of a recently invented substance which, though as smooth as glass, is never slippery. And as it practically never wears out, and is never torn up, we may be pardoned for looking back on the old style of affairs in New York with amused superiority. There are, of course, no horses to be seen, for their presence in the city is strictly forbidden by a city ordinance. A few unprogressive people in the back country districts still use horses to haul the old creaking, rattlety-bang wagons and carriages that were until recently the only means of locomotion, aside from that other antiquated invention, the steam railway car. But the recent development of electric locomotion has superseded all this in the cities and towns. There are great viaducts on which electric cars are run to every part of the city, for through passengers. But for short trips we never use these cars, because we don't need them. Every one, even the day laborer, going to and from his work, has his own electric carriage. They are neat and jaunty-looking affairs, made in all sizes to accommodate from one to twenty persons, having two large wheels behind and one small wheel in front, and they are so simple in construction that an infant could manage them. All you have to do is to get in, touch a button, and you are off. One little lever regulates the speed, which ranges from a snail's pace to twenty-five or thirty miles an hour; and another little lever enables you to steer. You need no track, but can speed wherever you please and as you please. With such beautifully smooth and clean pavements—for the age of unclean streets is happily a thing of the past—the luxurious comfort of traveling can easily be imagined.

But that is not all. Not only in our social and industrial life, but in our means of locomotion we have absolutely banished noise from the city. One of the things which we cannot understand about our New York ancestors is how they lived in the intolerable noise they made, most of which was absolutely unnecessary. According to all accounts the din in their homes and factories and on their streets must have been both terrific and ceaseless. In fact, their civilization was as a civilization of clangor and noise. And yet so reconciled were they to it, apparently, that in looking over the files of old New York papers we see only a few passing references to it. Indeed, some of the cockneys of those days declared that they felt homesick when they were away from the noise and clamor of the city. And from all accounts their celebrations of the national holiday were simply a barbarous saturnalia of unmeaning noise. Verily our ancestors were queer customers. What a contrast the city presents to-day. No noisy or loud-voiced person can get into good society; our factories are absolutely noiseless, owing to the introduction of perfect machinery, and our vehicles, from the electric trains that run at the rate of 150 miles an hour to the little electric tricycles holding only one person, make no noise that can be heard ten feet away. The effect of this revolution on the life of the people has been profound and far-reaching, but we have not space here to dwell on it.

Dust, too, is banished, or, rather, it is not allowed to exist. We do not refer to the great masses of dried mud and filth that our ancestors used to have on their streets, and which, in one form or another, impregnated their whole physical being. As already intimated, all our streets to-day are as clean as a billiard table. We refer rather to the impalpable particles of matter that would naturally exist in the atmosphere of a great metropolis. To get rid of this dust, often laden with disease microcosms, we have a wonderful system of "dust consumers" on every street corner, and in every factory and shop of the city, which absolutely extract or "eat up" the foreign substances in the air. Our ancestors used to breathe in this dust; in fact, without knowing it, they themselves were "dust consumers." The result was seen in the prevalence of diseases, especially of the throat and lungs, and in the uniformly harsh voices of the people.

They never knew what it was to breathe clean air, while we never know what it is to breathe anything else. And not only is our air clean, it is pure. In every block of the city there are air-purifying machines which are almost human in their intelligence.

They not only draw from the air all that is noxious and vitiating, but they actually improve the air which nature furnishes, making it more fit for breathing. Therefore instead of our citizens going to the mountains or the seashore to get a breath of fresh air, people from the country come to Manhattan when they feel the need of fresh air. That is, a few of them do; for, as in the old days, country people are strangely indifferent to the importance of fresh air. For the last forty years, since we first began to clean and purify our air, the average increase in longevity has been a little more than five years. The old philosophers used to waste a great deal of time in trying to find the elixir of life. We engage in no such vain quest; or, rather, we find the real elixir of life in a more intelligent understanding of the laws of life. The nearer we get to the conditions that nature intended, the longer we will live. How simple, and yet how many thousand years it has taken the world to find it out!

Underneath the streets there is a great and comprehensive system of other streets brilliantly lit with electricity, where most of the business of the city is done. Express wagons, drays, trucks, etc., are confined to these streets, thus leaving the upper streets for the exclusive use of the people. Underneath the city, also, is a magnificent system of sewerage, more perfect than anything known in the days of old New York. There are no longer any garbage wagons with their disgusting adjuncts. Connected with every house there is a shute which is opened once a day for the reception of all detritus. It is immediately carried into immense pipes through which it is conveyed to great establishments outside of the city, where it is made innocuous by recently invented chemical processes. The result in health and happiness from this admirable system of sanitation can hardly be estimated.

Another thing that adds greatly to the pleasure of living is the frequent flooding of the streets with salt or fresh water. On a hot summer day, for instance, this can be done at a moment's notice, and at the same time, by an ingenious device, sea air, laden with the delightful odor of salt spume, can be distributed through the city. This sea air is cooled, and is made to circulate as a breeze, no matter how calm the day may be. Another interesting arrangement is a system of awnings to cover the streets, when necessary, in summer, and of glass roofs for the streets in winter. The citizens are thus able to travel on the streets without suffering from heat in summer or from cold or snow in winter.

Since the great anti-liquor revolution, which took place sixty years ago, there has not been a licensed saloon in the city, and the number of habitual drinkers is very small. The causes which led up to this revolution had been gathering force for generations. The saloons increased enormously in number and power with the help of the politicians, and the latter in turn ruled with the help of the saloons. It was a game of seesaw, with the saloons and the politicians alternately on top, but with the people always at the bottom. Crime and ruin, moral and physical, held sway in every grade of society. The Prohibitionists tried in vain to stem the tide of evil, and good citizens began to despair.

Then, no one knows just how, a frenzy of hot indignation spread through the community. Good citizens in every walk of life, few of whom were Prohibitionists, and many of whom were themselves moderate drinkers, though recognizing the wisdom of abstinence, banded themselves together to suppress the curse of drink. The suppressed fury of years got the better of them, and a wild saturnalia of indefensible violence ensued. Distilleries and breweries were burned, thousands of liquor shops were wrecked and their contents poured into the sewer. Hundreds of saloon keepers and disreputable politicians were hanged on lamp posts, and thousands of others were driven out of the city. Lawless and criminal as the uprising was—and no one attempted to justify it—it proved to be the salvation of Manhattan. It ended forever the domination of the saloon and the saloon politician. It was the triumph, not of prohibition, but of abstinence, two things which, though often confused, are radically different. To abstain is always feasible, to prohibit is not. Abstinence is the higher virtue, and it has only become possible through the growth of moral character in the people. Among us a man who doesn't abstain is as loathsome a being as was the brutal murderer in the old days. With such a public opinion dominant there is nothing to fear from the drink habit. It lurks only in a few dark corners, and even then is so attenuated as to be harmless.

And what a revolution it was! To take one fact, a per capita equivalent of the amount that used to be spent in drinking and other forms of vice, as well as on the institutions made necessary by the drink habit, is now voted every year to the "Pleasure and Profit Fund." Out of this fund we maintain a number of splendid theaters, opera houses, music halls, and places of popular entertainment and instruction. The best artists of the world are engaged for these places, and all citizens are admitted to them free of charge. This does not promote pauperism, for recreation and amusement are properly a part of our education, and even our benighted ancestors believed in making education free.

The old socialistic dream of a deadening equality has not been realized among us. Some of us are rich and some of us are poor; some wise and some foolish. But there are no extremes of wealth and poverty as there were in the old days. Our wealthy citizens long ago realized the folly and danger of amassing wealth, folly because they could not possibly use or enjoy more than a certain portion of it, and danger because it sowed the seeds of revolution and anarchy by exciting the anger and envy of less-favored citizens. So when a citizen acquires a certain specified sum which is amply sufficient to maintain himself and family in luxurious comfort, he either stops acquiring wealth or, if he does not stop, he is obliged to turn over his surplus wealth to a municipal fund called the "Brotherhood Fund." Some men have a peculiar aptitude for making money, and love to do so for the pleasure it gives them, just as they would love a game of chance. It is not a very noble characteristic, but such as it is, we turn it to account by making those men help those who are less fortunate. In a word, the Brotherhood Fund is used to train, educate, and wisely assist the citizens who do not have much natural capacity to make their way in life, or who, for some reason, have been handicapped in their efforts to earn a living. The result of all this is that there are no very poor people among us, except a very few who are incapable or incorrigible, and these we take care of in institutions.

The spell ceases to work. The vision of the greater New York that may be, may we not hope of the New York that is to be, becomes blurred and indistinct. At last it disappears entirely and our eyes again look upon the concrete New York that now is. The contrast between the possible and the actual is one calculated to make us sad. But we will be optimists in spite of so much to discourage us. If, as the inspired penman declared, faith is the substance of things hoped for, the evidence of things not seen, then we have faith that New York will some day be worthy of the love and admiration of all her children, and our dreams about her greatness and glory will be realized facts.—*N. Y. Tribune.*

The heights of the figures illustrate the proportionate amounts spent in England on education, tea, coffee and cocoa, milk, bread, and alcoholic liquors.—*Daily Graphic.*

JOHN BULL'S DRINK BILL.

THE PRECIPITATION OF COPPER BY IRON.

By J. Essner.

When roasted cupreous pyrites is alternately moistened and dried in the air and then extracted with water, a solution of copper sulphate and ferric salts is obtained. If this solution is treated at 70 to 80° C. with metallic iron, a precipitate of metallic copper is formed, which, however, contains such a large amount of ferric hydrate that it is difficult to separate the copper. All kinds of iron were employed for the precipitation of the copper in these experiments, and the latter was obtained in three different states—pulverulent, granular, and fibrous. Experiments made with carefully chosen iron show that the structure of the latter is of considerable influence on that of the copper, which could be obtained in the granular and fibrous forms at will. The cause of the separation of ferric hydrate was found to be the presence of a basic ferric sulphate of the

formula $Fe_2(OH)_4SO_4$ in the solution. This salt decomposes when treated with metallic iron into neutral sulphate and ferric hydrate:

$$6\,Fe_2(OH)_4SO_4 + Fe_2 = 6\,FeSO_4 + 4\,Fe_2(OH)_6$$

When a very dilute solution of neutral ferric sulphate is treated with iron in the same way no precipitation of hydrate occurs, but rather a reduction of some of the ferric to ferrous salt. In order to prevent the precipitation of hydrate the author makes the liquor obtained from the burnt pyrites slightly acid with sulphuric acid, and is then able to obtain a very pure deposit of copper by the action of iron.—*Chem. Zeit.*

THE FIXATION OF FREE NITROGEN.*

FROM the results of the experiments of Boussingault, and also of those made at Rothamsted under conditions of sterilization and inclosure more than thirty years ago, Sir J. B. Lawes and the author had always concluded that at any rate our agricultural plants did not assimilate free nitrogen. They had also abundant evidence that the Papilionaceæ, as well as other plants, derived much nitrogen from the combined nitrogen in the soil and sub-soil. Still, they had long recognized that the source of the whole of the nitrogen of the Papilionaceæ was not explained; that there was, in fact, "*a missing link*"! They were, therefore, prepared to recognize the importance of the results first announced by Prof. Hellriegel in 1886; and they had hoped to commence experiments on the subject in 1887, but they had not been able to do so until 1888. Those first results showed a considerable formation of nodules on the roots, and coincidently great gain of nitrogen, in plants grown in sand (with the plant ash) when it was microbe-seeded by a turbid watery extract of a rich soil.

In 1889 and since, they had made a more extended series. The plants were grown in pots in a glass house. There were four pots of each description of plant, one with sterilized sand and the plant ash, two with the same sand and ash, but microbe-seeded with watery extract, for some plants from a rich garden soil, for lupins from a sandy soil in which lupins were growing luxuriantly, and for some other plants from soil where the particular plant was growing. In all, in 1889 and subsequently, they had grown in this way four descriptions of annual plants—namely, peas, beans, vetches, and yellow lupins; and four descriptions of longer life—namely, white clover, red clover, sainfoin, and lucerne. Enlarged photographs of the above-ground growth, and of the roots, of the peas, the vetches and the lupins, so grown, were exhibited. Without microbe seeding there was neither nodule formation nor any gain of nitrogen; but with microbe seeding there was nodule formation, and, coincidently, considerable gain of nitrogen.

As, however, in this exact quantitative series, the plants were not taken up until they were nearly ripe, it was obvious that the roots and their nodules could not be examined during growth, but only at the conclusion, when it was to be supposed that the contents of the nodules would be to a great extent exhausted. Another series was, therefore, undertaken, in which the same four annuals, and the same four plants of longer life, were grown in specially made pits, so arranged that some of the plants of each description could be taken up, and their roots and nodules studied, at successive periods of growth: the annuals at three periods—namely, first when active vegetation was well established, secondly when it was supposed that the point of maximum accumulation had been approximately reached, and thirdly when nearly ripe; and the plants of longer life at four periods—namely, at the end of the first year, and in the second year when active vegetation was re-established, when the point of maximum accumulation had been reached, and lastly when the seed was nearly ripe. Each of the eighth descriptions of plant was grown in sand (with the plant ash) watered with the extract from a rich soil; also in a mixture of two parts rich garden soil and one part of sand. In the sand the infection was comparatively local and limited, but some of the nodules developed to a great size on the roots of the weak plants so grown. In the rich soil the infection was much more general over the whole area of the roots, the nodules were much more numerous, but generally very much smaller. Eventually the nodules were picked off the roots, counted, weighed, and the dry substance and the nitrogen in them determined.

Taking the peas as typical of the annuals, and the sainfoin of the plants of longer life, the general result was that at the third period of growth of the peas in sand the amount of dry matter of the nodules was very much diminished, the percentage of nitrogen in the dry matter was very much reduced, and the actual quantity of nitrogen remaining in the total nodules was also very much reduced. In fact, the nitrogen of the nodules was almost exhausted. The peas grown in rich soil, however, maintained much more vegetative activity at the conclusion, and showed a very great increase in the number of nodules from the first to the third period; and with this there was also much more dry substance, and even a greater actual quantity of nitrogen, in the total nodules at the conclusion. Still, as in the peas grown in sand, the percentage of nitrogen in the dry substance of the nodules was very much reduced at the conclusion. In the case of the plant of longer life, the sainfoin, there was, both in sand and in soil, very great increase in the number of nodules, and in the actual amount of dry substance and of nitrogen in them, as the growth progressed. The percentage of nitrogen in the dry substance of the nodules also showed, even in the sand, comparatively little reduction, and in soil even an increase. In fact, separate analyses of nodules of different character, or in different conditions, showed that while some were more or less exhausted and contained a less percentage of nitrogen, others contained a high percentage, and were doubtless new and active. Thus, the results pointed to the interesting conclusion that, in the case of the annual, when the seed is formed, and the plant more or less exhausted, both the actual amount of nitrogen in the nodules, and its percentage in the dry substance, are greatly reduced, but that, with the plant of longer life, although the earlier formed nodules become exhausted, others are constantly produced, thus providing for future growth.

As to the explanation of the fixation of free nitrogen, the facts at command did not favor the conclusion that under the influence of the symbiosis the higher plant itself was enabled to fix the free nitrogen of the air by its leaves. Nor did the evidence point to the conclusion that the nodule-bacteria became distributed through the soil and there fixed free nitrogen, the compounds of nitrogen so produced being taken up by the higher plant. It seemed more consistent, both with experimental results and with general ideas, to suppose that the nodule-bacteria fixed free nitrogen within the plant, and that the higher plant absorbed the nitrogenous compounds produced. In other words, there was no evidence that the chlorophylous plant itself fixed free nitrogen, or that the fixation takes place within the soil, but it was more probable that the lower organisms fix the free nitrogen. If this should eventually be established, we have to recognize a new power of living organisms—that of assimilating an elementary substance. But this would only be an extension of the fact that lower organisms are capable of performing assimilation work which the higher cannot accomplish; while it would be a further instance of lower organisms serving the higher. Finally, it may here be observed that Loew has suggested that the vegetable cell, with its active protoplasm, if in an alkaline condition, might fix free nitrogen, with the formation of ammonium nitrite. Without passing any judgment on this point, it may be stated that it has frequently been found at Rothamsted that the contents of the nodules have a weak alkaline reaction when in apparently an active condition—that is, while still flesh-red and glistening.

As to the importance of the fixation for agriculture, and for vegetation generally, there is also much yet to learn. It is obvious that different Papilionaceæ growing under the same external conditions manifest very different susceptibility to, or power to take advantage of, the symbiosis. The fact, as shown by Prof. Nobbe, that papilionaceous shrubs and trees, as well as herbaceous plants, are susceptible to the symbiosis, and under its influence may gain much nitrogen, is of interest from a scientific point of view as serving to explain the source of some of the combined nitrogen accumulated through ages on the surface of the globe; and also from a practical point of view, since, especially in tropical countries, such plants yield many important food materials, as well as other industrial products.

In conclusion, it will be seen that the experimental results which have been brought forward constitute only a small proportion of those already obtained or yet to be obtained at Rothamsted, but they have been selected as being to a great extent typical, and illustrative of the lines of investigation which are being carried out.

* Abstract of a paper read before the Agricultural Chemistry Section of the Naturforscher Versammlung at Halle a. S., by Dr. J. H. Gilbert, F.R.S., September 24, 1891.—*Nature.*

ON A NEW METHOD OF PURIFYING CHLOROFORM.

By RENE DU BOIS REYMOND, M.D.

(*Communicated by Dr. Frederic Hewitt.*)

IT is now about a year ago that, by the advice of Prof. Liebreich, the Berlin pharmacologist, Prof. Pictet, formerly of Geneva, introduced a new method for the manufacture of chloroform. The main feature of the innovation is the application of intense cold, by means of which the chloroform is caused to crystallize, while the impurities it contains are excluded, and can be drained off. The process, as described in the patent, consists of three stages. First of all the chloroform is subjected to a mild degree of cold, by which moisture and other easily frozen matter is removed. This generally only amounts to a small quantity of snow-like substance, sometimes of a yellowish tint. It is readily eliminated by means of a filter previously placed at the bottom of the vessel, and afterward pulled up so as to receive all the solid particles on the way. The second and principal part of the proceeding consists in freezing the whole quantity of chloroform, draining off the liquid residue, and allowing the pure crystals, thus separated, again to liquefy. Thirdly and lastly, the pure chloroform is further refined by distilling under diminished pressure at a very low temperature.

The apparatus used to produce the necessary cold was invented by Prof. Pictet. The chloroform purified by crystallization possesses a very mild and agreeable odor. Tested by the ordinary tests, it appears perfectly pure. But its especial characteristic is its remarkable degree of durability. It has been affirmed that absolutely pure chloroform of 1·500 specific gravity will not keep. But this is evidently a mistake. The alcohol which is usually added to chloroform is only of use when impurities are present, and is quite unnecessary if the anæsthetic is chemically pure. As this is indisputably the only way in which alcohol affects the chloroform, it follows, from the mere fact that chloroform with alcohol seems to keep better than without, that really pure chloroform would keep still better. This conclusion is borne out by facts. The case is analogous to that of nitrate of silver, which will remain unchanged by the action of sunlight if perfectly pure and shut off from the air. The pure chloroform keeps as well without as any other chloroform with alcohol. This has been proved by the following tests. The addition of bichromate of potash indicates the total absence of alcohol previously contained in the drug. Tests as to durability were carried on during several months. Samples of chloroform in bottles of clear glass were exposed to the action of sunlight on the roof of the laboratory, and tested at certain intervals with nitrate of silver, iodide of zinc, and starch. While ordinary chloroform invariably gave signs of decomposition on the very next day, the crystallized chloroform on an average kept unaltered for a week. Repeated trials were made by means of a combination of the nitrate of silver and the sulphuric acid tests, in the following manner. A small quantity of chloroform was poured into a phial containing about the same volume of concentrated sulphuric acid, and was allowed to remain there, being well shaken from time to time. At fixed intervals the nitrate of silver test was applied to samples of the chloroform thus treated. The presence of the sulphuric acid acts as a permanently strong decomposing agent, and this method is therefore equal to and more handy than the sunlight test. Ordinary chloroform, as a rule, shows signs of decomposition after a few minutes; the best kinds will stand about twenty-four hours; but the crystallized chloroform held out for several days.

The new chloroform is at present being tried at the principal hospitals of Berlin, and the following remarks on its clinical properties may be ventured on: 1. There is no difference as to the excitability during the inhalation, or vomiting after. 2. Anæsthesia is produced more promptly and with smaller doses than ordinarily, frequently appearing before extinction of reflex action. 3. Anæsthesia remains after stoppage of inhalation longer than usual, sometimes even beyond return of consciousness.—*The Lancet.*

ANALYSIS OF FERMENTED LIQUORS.*

1. *Specific Gravity.*—This determination is made with a pycnometer, or a Westphal balance controlled by a pycnometer. Temperature, 25° C.

2. *Alcohol.*—One hundred cubic centimeters of wine at 25° C. distilled (preferably in glass) give x cubic centimeter alcohol.

3. *Extract.*—Fifty cubic centimeters of wine (at 25° C.), in case of sweet wines a less amount, are evaporated in a platinum dish on the water bath to a proper consistency, and then dried in a drying oven at 100° C. to constant loss of weight. Constant loss of weight is assumed when three weighings, with equal intervals between the first and second and second and third, give equal differences between the successive weighings. Weighings are to be made at intervals of fifteen minutes.

NOTE ON THE EXTRACT DETERMINATION.—So far as we are aware, no satisfactory method has been given for the determination of the extract of wine. We think that the method of the Bavarian chemists is, on the whole, the best. As the object is for the purpose of comparison with some standard, we cannot do better, we think, than to follow the standard most generally adopted. We have in mind, when the new chemical laboratory of the University of California is fitted up, to make some experiments on the determination of this extract in a vacuum at a moderate temperature. We should modify somewhat the method of Gautier. However, until some better method has been established, we believe the method given will be most satisfactory.

4. *Acidity* (total acid constituents of the wine expressed as tartaric acid).—If carbonic acid is present, expel by shaking. Titrate with dilute alkali solution. The neutral point is determined by adding a drop of solution to delicate litmus paper.

5. *Volatile Acids* (expressed as acetic acid).—Distill in a current of steam, and titrate the carefully condensed distillate with standard alkali decinormal.

6. *Glycerin.*—(1) This is determined in dry wines as follows: The alcohol is driven off from 100 c. c. wine, lime or magnesia added, and the whole evaporated to dryness. The residue is boiled with 90 per cent. alcohol, filtered, and the filtrate is evaporated to dryness. This residue is dissolved in 10 to 20 c. c. alcohol, 15 to 30 c. c. ether added, and the mixture allowed to stand until it is clear. It is then decanted from the sticky precipitate into a glass-stoppered weighing bottle, evaporated to constant loss of weight, and weighed.

(2) The following method is employed for sweet wines: One hundred cubic centimeters wine are measured into a porcelain dish and evaporated on the water bath to a sirupy consistency, mixed with 100 to 150 c. c. absolute alcohol, poured into a flask, ether added in the proportion of 1½ volumes to each volume of alcohol used, the flask well shaken and allowed to stand until the liquor becomes clear. This is then poured off, and the residue again treated with a mixture of alcohol and ether. The liquids are mixed, the alcohol and ether driven off, the residue dissolved in water and treated as in (1).

(3) In all glycerin determinations it is necessary to take into consideration the loss of glycerin due to its volatility with water and alcohol vapor, and accordingly to add to the glycerin found 0·100 gramme for each 100 c. c. of liquid evaporated.

(4) It is necessary to test the glycerin from sweet wines for sugar, and if any is present, it must be estimated by Soxhlet's or Knapp's method, and its weight subtracted from that of the glycerin.

7. *Sugar.*—This is to be determined by Soxhlet's or Knapp's method. The presence of unfermented cane sugar is to be shown by inversion, etc. *Polarization.*—(1) The wine is decolorized with plumbic subacetate.

(2) A slight excess of sodic carbonate is added to the filtrate from (1): 2 c. c. of a solution of plumbic subacetate are added to 40 c. c. white wine, and 5 c. c. to 40 c. c. red wine, the solution is filtered, and 1 c. c. of a saturated solution of sodic carbonate added to 21·0 or 22·5 c. c. of the filtrate.

(3) The kind of apparatus used and the length of the tube are to be given, and results estimated in equivalents of Wild's polaristrobometer with 200 mm. tubes.

(4) All samples rotating more than 0·5 degree to the right (in 2 mm. tubes, after treating as above) and showing no change, or but little change, in their rotatory power after inversion, are to be considered as containing unfermented glucose (starch sugar) residue.

(5) Rotatory power of less than 0·3 degree to the right shows that impure glucose has not been added.

(6) Wines rotating between 0·3 degree and 0·5 degree to the right must be treated by the alcohol method.

(7) Wines rotating strongly to the left must be fermented, and their optical properties then examined.

8. *Tannin.*—Determine with Neubauer's permanganate method.

9. *Potassic Bitartrate.*—The determination of potassic bitartrate as such is to be omitted.

10. *Tartaric, Malic, and Succinic Acids.*—(1) According to Schmidt and Hiepe's method. (2) Determination of tartaric acid according to the modified Berthelot-Fleury method. (3) If the addition of 1 gramme finely powdered tartaric acid to 100 grammes wine produces no precipitate of potassic bitartrate, the modified Berthelot-Fleury method must be employed to determine free tartaric acid.

11. *Coloring Matter.*—(1) Only aniline dyes are to be looked for. (2) Special attention is to be paid to the spectroscopic behavior of rosaniline dyes as obtained by shaking wines with amylic alcohol before and after saturation with ammonia.

* As adopted by the Association of Official Agricultural Chemists of the United States for 1890-1891.

12. *Inorganic Matter* (ash).—Burn in ordinary manner in flat platinum dish at as low a heat as possible; repeated moistening, drying, and heating to redness are advisable to get rid of all organic substances.

13. *Citric Acid.*—Presence to be shown by a qualitative test, as baric citrate.

14. *Sulphuric Acid.*—To be determined in the wine after adding hydrochloric acid.

15. *Chlorine.*—To be determined in the nitric acid solution of the burnt residue by Volhard's method.

16. *Lime, Magnesia, and Phosphoric Acid.*—These are determined in the ash fused with sodic hydrate and potassic nitrate, the phosphoric acid by the molybdenum method.

17. *Potash.*—Either in the wine ash, as the platinum double salt, or in the wine itself by Kayser's method.

18. *Gums.*—Presence shown by precipitation by alcohol; 4 c. c. wine and 10 c. c. 96 per cent. alcohol are mixed. If gum arabic has been added, a lumpy, thick, stringy precipitate is produced, whereas pure white becomes at first opalescent and then flocculent.

19. *Sulphurous Acid.*—One hundred c. c. of wine are distilled in a current of carbonic acid after the addition of phosphoric acid. The distillate, carefully condensed, is oxidized with bromine, and the amount of H_2SO_4 determined.—*American Druggist.*

BLEACHING BY MEANS OF HYPOCHLORITE OF ALUMINUM.

By M. WEISS.

A SOLUTION of hypochlorite of aluminum has long been employed as a bleaching agent, under the designation of Wilson's water, and has been much appreciated on account of its activity as a bleaching agent, and also owing to the fact that it does not attack the fiber of the material being bleached to so great an extent as chloride of lime.

The production of this bleaching liquor of aluminum hypochlorite has hitherto been obtained by mixing a solution of aluminum sulphate and an aqueous extract of chloride of lime. This method of producing the bleaching liquor reduces the cost of production considerably, since the two original compounds employed, chloride of lime and sulphate of alumina, are relatively dear.

Mr. Weiss has found that a more potent bleaching compound can be prepared by acting upon the aluminates of sodium, calcium, and magnesium with chlorine gas, in a manner precisely identical with that employed in the preparation of chloride of lime.

The bleaching compounds of aluminum can be obtained either in the liquid or solid state.

In the first case the chlorine gas is passed into a solution of sodium aluminate of convenient strength, or into water, which holds in suspension aluminate of calcium or magnesium; or the two together.

In the second case, the chlorine is passed over the solid aluminates and the bleaching compound thus obtained in th solid form, in the same way as ordinary bleaching powder.

Mr. Weiss allows the chlorine to pass into solution containing the aluminates in suspension, or over the solid substance, as long as there is any perceptible absorption, taking, of course, all the necessary precautions, such as avoiding too high a temperature, as are requisite in the production of ordinary bleaching powder. When the chlorine escapes in large quantities from the apparatus, the reaction is complete and the bleaching compound contains its full complement of active chlorine.

By prolonging the action of the chlorine a further decomposition ensues, accompanied by the evolution of oxygen gas. At the same time the total chlorine in the compound is increased but the amount of active chlorine is reduced. This evolution of oxygen may be observed, when the aluminates are employed dissolved or suspended in water, by the formation of bubbles of gas and frothing.

From analysis made by Mr. Weiss, the formation of the bleaching compounds would appear to take place in accordance with the reactions expressed in the following equations:

(A.) ALUMINATE OF SODIUM (Al_2O_3 by $3\,Na_2O$):

$$Al_2(HO)_6\,(6N\ HO) + 30\ Cl = 2\begin{pmatrix}Al_2(ClO)_3\\(OH)_3)\end{pmatrix} 9\ NaClO + Al_2\,Cl_6 + 9\ NaCl + 15\ H_2O.$$

(B.) ALUMINATE OF CALCIUM (Al_2O_3, $3\,CaO$):

$$3(Al_2(OH)_6,\ 3\,Ca(OH)_2) + 24\,Cl = 2\begin{pmatrix}Al_2(ClO)_3\ 3\ Ca & ClO\\(HO)_3 & HO\end{pmatrix} + Al_2\,Cl_6 + 3\ CaCl_2 + 12\ H_2O.$$

The reaction with magnesium aluminate is the same as equation B.

The determination of the actual composition of these compounds is as difficult a matter as the determination of the real composition of bleaching powder has been.

These compounds of aluminum, produced by the patent process of Mr. Weiss, are exceptionally active as bleaching agents, on account of the evolution of ozonized oxygen, which experiment upon the large scale has shown can be successfully accomplished; paper pulp, tissues, etc., being completely bleached in a short time, without the preliminary treatment in an acid bath, etc., entailed when chloride of lime is employed. While lastly, the most important point connected with the use of these aluminum bleaching compounds is that its action upon the material being bleached is very small, whereas this action when chloride of lime is employed is most deleterious, and has always been one of the difficulties attendant upon the use of chloride of lime as a bleaching agent.—*Mon. de la Teinture.*

TERPENE FROM COMPRESSED GAS OILS.

PORTABLE or compressed gas is prepared in France from the heavy paraffinoid oils obtained from the bituminous schists of Autun or less frequently from material similar to Scotch boghead. The oils are carburized at a cherry red heat in long cast tubes, and the resulting gas is compressed in cylinders; in this operation light liquids condense, holding in solution such gases as butylene, ethylene, etc. The authors have examined the gas oils obtained from both the above sources and find them practically identical. They distill between 20° and 300°, leaving a tar, and yield about 60 per cent. of benzene, 10 per cent. of toluene, 6 per cent. of light unsaturated hydrocarbons, and 10 per cent. of higher oils between 140° and 190°, which give no definite boiling point, but undergo steady decomposition at about 167°. Repeated fractionation of the light oils thus produced yielded a product C_5H_8, boiling point 42·5°, density 0·803, vapor density 2·45 (theory 2·35), named by the authors pyropentylene; it has the principal terpene properties. It has a peppery taste and characteristic odor, is not acted on by ammoniacal silver or cuprous salts, but ammonia potassic solutions of silver deposit silver mirrors in its presence. Concentrated aqueous silver nitrate produces a white crystalline precipitate; aqueous sulphurous acid forms with it, white crystals of the composition $C_{10}H_{16}$ $2H_2SO_3$ insoluble in almost all reagents except alkalies, and which exhibit a remarkable tendency to retain small quantities of iron. Halogen acids resinize it rapidly or cause it to explode, oxidizing agents even when dilute destroy it completely, while bromine gives rise to liquid derivatives. In the cold it gradually polymerizes, the density increasing regularly with the time of exposure, ultimately forming a solid $C_{10}H_{16}$, melting at 8° with a density 1·003 and called di-pyropenthylene, which depolymerizes on heating. Pyropenthylene is neither identical with valylene nor pirylene.—*Compt. Rend.*

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